SALINE WATER PROGRAM EXPANSION

THE UNIVERSITY
OF MICHIGAN
JUL 1 1960
MAIN
READING ROOM

HEARING

BEFORE THE

SUBCOMMITTEE ON IRRIGATION AND RECLAMATION

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE

EIGHTY-SIXTH CONGRESS

SECOND SESSION

ON

S. 3557, S. 3446, and S. 2816

BILLS PERTAINING TO THE EXPANSION AND EXTENSION OF THE SALINE WATER PROGRAM

JUNE 8, 1960

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SALINE WATER PROGRAM EXPANSION

WEDNESDAY, JUNE 8, 1960

U.S. SENATE,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION,
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

The subcommittee met, pursuant to call, at 10 a.m., in room 3110, Senate Office Building, Senator Clinton P. Anderson (chairman of the subcommittee) presiding.

Present: Senators Clinton P. Anderson, of New Mexico; Henry M. Jackson, of Washington; Frank E. Moss, of Utah; and Gordon Allott, of Colorado.

Committee staff members present: Goodrich W. Lineweaver, professional staff member.

Senator ANDERSON. The Subcommittee on Irrigation and Reclamation will come to order.

The hearing today relates primarily to S. 3557, which has as its main objective the acceleration of interest in the saline water program, initiated in 1952 largely at the instance of Oscar L. Chapman, the then Secretary of the Interior.

Subsequent legislation has given the program limited expansion with emphasis on demonstrations of proven methods of converting sea water to potable uses on the Pacific and Atlantic seaboards, and gulf coast areas. Demonstrations for the treatment of brackish water in the interior has also been emphasized.

(S. 3557, S. 3446, and S. 2816 and departmental reports pertaining thereto follow:)

[S. 3557, 86th Cong., 2d sess.]

A BILL To expand and extend the saline water conversion program under the direction of the Secretary of the Interior to provide for accelerated research, development, demonstration, and application of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

Whereas a serious problem exists in many areas of the country today because natural fresh water supplies have remained relatively constant while population and the consumption of fresh water have increased tremendously;

Whereas the areas in which water shortages exist may be expected to increase at an alarming rate if reliance is placed solely upon natural fresh water supplies;

Whereas, as the limit of the natural fresh water supplies is approached, this country will become increasingly dependent upon the conversion of salt and brackish waters for its supplies of water suitable for agricultural, industrial, municipal and other beneficial consumptive uses;

Whereas the Federal Government has been conducting a limited program to develop lower cost means of converting saline waters into water suitable for beneficial consumptive purposes;

Whereas, although some significant progress has been made under that program, the answers to low-cost conversion of saline waters has not been found as yet;

Whereas a considerable expansion of the Federal program of research, development, and demonstration, and of aid to public bodies in practical application, could yield enormous dividends to the Nation in terms of lowered saline water conversion costs and new supplies of beneficial water to a growing number of needy areas; and

Whereas the future well-being and development of this country, its civil and military defense, its world prestige, and the well-being of its friends and allies in the free world, require a sharp acceleration of the national effort to develop lower cost methods of converting sea or other saline waters into water suitable for beneficial consumptive uses: Now, therefore,

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act of July 3, 1952, as amended (42 U.S.C. 1951–1958), is amended to read as follows:

"TITLE I—SALINE WATER RESEARCH AND DEVELOPMENT

"POLICY AND PURPOSE

"SEC. 101. In view of the acute shortage of water in many areas of the Nation, and in recognition of the increasing importance of finding new sources of supply to meet the present and future water needs of this country, the Congress reaffirms and declares its policy to assist in the development of practicable low-cost means of producing, from sea or other saline waters, water of a quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses on a scale sufficient to determine the feasibility of the development of such production and distribution on a large scale. It is the purpose of this title to authorize a continuing, accelerated, and expanded saline water research and development program in furtherance of the foregoing policy objective.

"ADMINISTRATION

"SEC. 102. The provisions of this Act shall be administered by the Secretary of the Interior (hereinafter referred to in this title as the 'Secretary') acting through such agencies of the Department of the Interior as he deems appropriate.

"FUNCTIONS

"SEC. 103. (a) STUDIES AND RESEARCH.—The Secretary shall conduct research and make careful engineering studies to ascertain the lowest investment and operating costs and the best designs and conditions of operation to accomplish the purposes of this Act. Such research shall include, but not be limited to (1) the use of small conversion units, (2) methods of extraction and use of by-products, (3) an evaluation of various materials for use in construction, and of types of components and equipment, (4) methods of overcoming or lessening corrosion, (5) the use of atomic energy in conversion systems, (6) methods of preventing scale, (7) the development of improved membranes, and (8) the advancement of scientific data on thermodynamics, polarization, properties of solutions, ion exchange, absorption, and brine disposal. In connection with studies to ascertain the lowest investment and operating costs, the Secretary shall consider and evaluate methods for the recovery and marketing of byproducts resulting from and incident to the production of water by the conversion of sea and other saline waters for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such by products.

"(b) PROCESS DEVELOPMENT.—The Secretary shall conduct technical development work to determine the results of research by laboratory and pilot plant testing with a view to developing processes to the point where they can be demonstrated on a large and practical scale. Such development work shall include the laboratory or pilot plant testing of saline water conversion processes, including (1) distillation processes, (2) freezing processes, (3) membrane and ion-exchange processes, (4) solar distillation processes, and (5) other promising processes, such as gas hydrates and solvent extraction. The Secretary shall also, subject to the provisions of section 105, undertake the laboratory or pilot plant testing of saline water conversion systems suitable for civil defense purposes.

"(c) INVESTIGATION, COORDINATION, AND CORRELATION OF SCIENTIFIC DATA.—The Secretary shall, with a view to obtaining and making available the most advanced information concerning saline water conversion developments—

"(1) assemble and maintain pertinent and current scientific literature, both domestic and foreign, and issue periodically bibliographical data with respect to such literature;

"(2) cause on-site inspections to be made of promising projects, domestic and foreign, and cooperate and participate insofar as practicable, in their development;

"(3) provide for the calling of, and sending representatives to, national and international conferences relating to saline water conversion;

"(4) stimulate, by grant or otherwise, pioneering research in matters relating to saline water conversion by educational institutions, scientific organizations, and industrial and engineering firms; and

"(5) coordinate, correlate, and publish information obtained with a view to advancing the development of low-cost saline water conversion projects.

"(d) ECONOMIC STUDIES.—With a view to clarifying the economics of saline water conversion and thereby stimulate development, the Secretary shall undertake economic studies and market surveys to determine (1) present and prospective comparative costs of natural fresh water, and potable water by the leading saline water conversion processes in various, representative areas, and (2) present and prospective markets for saline water conversion equipment.

"POWERS

"SEC. 104. In carrying out his functions under section 103, the Secretary may—

"(1) acquire, by purchase, license, lease, or donation, secret processes, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or other property acquired hereunder shall not exceed that necessary to carry out experiments and demonstrations authorized by this title;

"(2) make research grants to and enter into noncompetitive contracts with any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work to be carried out under this title;

"(3) acquire the services of chemists, physicists, engineers, and such other personnel as may be deemed necessary;

"(4) utilize the facilities of existing Federal scientific laboratories; and

"(5) establish and operate a central laboratory and test site, serving both sea and brackish water, for the purpose of conducting the continuous research, testing, development, and programing necessary to effectuate the purposes of this title.

"COOPERATION WITH OTHER AGENCIES

"SEC. 105. The Secretary shall, in carrying out the purposes of this title, cooperate with other Federal, State, or municipal departments, agencies, or instrumentalities, and with interested persons, firms, institutions, and organizations. Research activities undertaken by the Secretary shall be coordinated or conducted jointly with the Department of Defense to the greatest practicable extent compatible with military and security limitations to the end that research and developments under this title which are primarily of a civil nature will contribute to the defense of the Nation, and that research and developments in the same field which are primarily of a military nature and are conducted by the Department of Defense will be made available to advance the purposes of this title and to strengthen the civil economy of the Nation. Similarly the fullest cooperation by and with the Atomic Energy Commission and the Civil Defense Administration in research shall be carried out in the interest of achieving the objectives of this title.

"DISPOSAL OF WATER AND BYPRODUCTS

"SEC. 106. The Secretary is authorized, for the sole purpose of this title, to dispose of all water and other products produced as a result of his operations under this title pursuant to regulations prescribed by him. Nothing in this title shall be construed to alter existing law with respect to the ownership and control of water.

"DISPOSITION OF MONEY

"SEC. 107. All moneys received for products of the plants under this title shall be paid into the Treasury as miscellaneous receipts.

"REPORTS

"SEC. 108. The Secretary shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this title. Any such report may include suitable recommendations for further legislation.

"RULES AND REGULATIONS

"SEC. 109. The Secretary may issue rules and regulations to effectuate the purposes of this title.

"AUTHORIZATION FOR APPROPRIATIONS

"SEC. 110. There are hereby authorized to be appropriated such sums as may be required to carry out the provisions of this title: *Provided*, That not to exceed 10 per centum of the funds available in any year for research and development may be expended in cooperation with public or private agencies in foreign countries in the development of processes useful to the program in the United States: *And provided further*, That contracts or agreements made with public or private agencies in foreign countries shall provide that the results or information developed in connection therewith shall be available without cost to the United States.

"TITLE II—FINANCIAL ASSISTANCE FOR THE CONSTRUCTION OF CONVERSION PLANTS

"DECLARATION OF POLICY

"SEC. 201. It is the purpose of this title to stimulate the construction of plants for the production, from sea water or brackish water, of water that is suitable for municipal or other beneficial consumptive uses, and thereby make maximum use of the research for the development and utilization of saline waters that is authorized by title I of this Act, and maximum use of the demonstration plant program authorized by the Act of September 2, 1958 (72 Stat. 1706).

"APPLICATIONS FOR FINANCIAL ASSISTANCE

"SEC. 202. (a) Any State, or political subdivision or agency thereof, or publicly owned public utility organization (any such entity being hereinafter referred to as 'organization') may submit to the Secretary of the Interior, in such form as the Secretary may prescribe, an application for a loan, or an offer to sell to the United States securities of the organization, to finance the design and construction of a plant to produce, from sea water or brackish water, water that is suitable for municipal, industrial, domestic, or other beneficial consumptive use.

"(b) Any application for a loan or offer to sell securities hereunder shall include a showing that the organization (1) holds or can acquire, pursuant to State law, all lands and interests in land, and rights to the use of water, which are necessary for the successful construction, operation, and maintenance of the plant, and (2) is ready, able, and willing to finance by other means the portion of the cost of design and construction that is not covered by the loan application or offer to sell securities.

"(c) No application for a loan or offer to sell securities under this section shall be made in an amount which exceeds 90 per centum of the estimated cost of design and construction (exclusive of land and water costs), or $1,000,000, whichever is smaller.

"(d) As used in this section, the term 'State' includes any of the several States of the United States, the Commonwealth of Puerto Rico, and any of the territorial possessions of the United States.

"SUBMITTAL TO CONGRESS

"SEC. 203. (a) If the Secretary of the Interior approved an application or offer submitted under section 202, after finding that the proposed construction is feasible and that the loan or purchase of securities would be a reasonable risk, he shall transmit to the Congress the application or offer, his approval, and his findings.

"(b) No appropriation shall be made for a loan to, or a purchase of securities from, the organization prior to sixty calendar days (which sixty days shall not include days on which either the House of Representatives or the Senate is not in session because of an adjournment of more than three calendar days to a day certain) from the date on which the Secretary's findings and approval are submitted to the Congress and then only if, within said sixty days, the Congress does not disapprove the application or offer by concurrent resolution.

"TERMS APPLICABLE TO LOANS OR PURCHASES

"SEC. 204. Either concurrently with the submission to Congress of an application or offer, or after the time for congressional disapproval has expired without the adoption of a resolution of disapproval, the Secretary of the Interior may negotiate and execute an agreement with the organization which shall set out, among other things:

"(1) the maximum amount of the loan or the securities to be purchased;

"(2) the time and method for making the money available to the organization;

"(3) a plan for the repayment of the loan in not more than forty years in periodic installments that need not necessarily be in equal amounts, and for the payment of interest on unamortized balances, beginning three months after the plant first commences operation, at a rate determined by the Secretary which shall not exceed the average rate of interest computed as of the end of the calendar month next preceding the date on which such loan is made, borne by all outstanding interest-bearing marketable public debt obligations of the United States having a maturity date of fifteen or more years, adjusted to the nearest one-eighth of 1 per centum; or, in the case of an offer to sell securities, a plan of redemption that is consistent with the foregoing requirements with respect to a loan;

"(4) provisions for assuring and securing the prompt repayment of the loan and interest or for the redemption of the securities: and

"(5) provisions making the liability of the United States under the agreement contingent upon the availability of appropriations for the purpose.

"USE OF PLANTS FOR WHICH ASSISTANCE IS EXTENDED

"SEC. 205. Notwithstanding any other provision of law, the Secretary of the Interior is authorized to contract with a borrower under this title for the use of the borrower's plant facilities to further the research and demonstration programs authorized by title I of this Act, and the Act of September 2, 1958 (72 Stat. 1706), and to provide in the contract for a credit on the organization's loan, or for a cancellation of its securities, in an amount up to 25 per centum of the original amount thereof as compensation to the borrower for the use made of its facilities in connection with such programs.

"UNAVAILABILITY OF OTHER FINANCING

"SEC. 206. No loan or purchase of securities shall be made pursuant to this title if the Secretary determines that in his judgment the organization can obtain funds on reasonable terms from other sources.

"AUTHORIZATION FOR APPROPRIATIONS

"SEC. 207. There are authorized to be appropriated such sums, not to exceed $20,000,000 in the aggregate, as may be necessary to carry out the provisions of this title, and any such appropriation shall remain available until expended."

DEPARTMENT OF THE INTERIOR,
Washington, D.C., June 7, 1960.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

DEAR SENATOR MURRAY: This responds to the request of your committee for the views of this Department on S. 3557, which is a bill to amend the act of July 3, 1952, as amended, which act relates to the research, development, and utilization of saline water.

Title I of the bill which covers saline water research and development is substantially the same as the existing law except in connection with the authorization of appropriations and life of the program. It is similar in some respects to S. 3446, a bill to amend the act of July 3, 1952, as amended, relating to research and development and utilization of saline water, on which we have reported to your committee and reference should be made to that report in considering S. 3557. In some respects S. 3557 spells out in greater detail than in the present law work to be done by the Department in resolving the conversion problem, but in most instances the Department is doing all of that work under the general authority provided by the existing law.

Section 103(d) provides for the making of economic studies in connection with the present and prospective comparative costs of natural fresh water and water produced by conversion processes, and the present and prospective markets for saline water conversion equipment. It is felt that studies of this nature should be made and would be of value in determining the course to be followed.

Section 104(5) provides for the establishment and operation of a central laboratory and test site to provide for continuous research. Such a laboratory would be useful but it would require a large expenditure of money and equipment and from 75 to 100 scientists and technicians to operate it. At this time we have the advantage of the use of many scientists in private industry, with more than 40 different contracts and projects being carried on either in universities or private industry. It would not be possible to assemble in one laboratory the high quality of men now engaged in this research.

Section 110 of the bill authorizes the appropriation of such sums as may be required to carry out the provisions of the title, setting no limit on the amount of funds to be appropriated or time in which they are to be expended. This section contains the same provisions that appear in the existing law to the effect that not to exceed 10 percent of the funds available in any one year may be spent in cooperation with public and private agencies in foreign countries in the development of processes, and that any contracts or agreements made with public or private agencies of foreign countries shall provide that the information obtained will be available without cost to the United States.

Title II of the bill is substantially the same as S. 2816, a bill to authorize loans for the design and construction of sea and brackish water conversion plants, and for other purposes, on which we also have reported to your committee.

As we pointed out in that report the Housing and Home Finance Agency already has authority to make loans for community facilities, which we are informed includes the authority to make loans for saline water plants for community purposes. We feel the authority contained in S. 2816 and title II of this bill might be more appropriately conferred upon the Housing and Home Finance Agency. In particular, however, we wish to stress the importance of the provision of section 5 of S. 2816 which authorizes the Secretary of the Interior to provide a writeoff of a portion of any Federal loan made for the development of the saline water plant in the event a community would permit us to utilize that plant in connection with our research and development program in saline water. It is highly important in our opinion that any loan program and the research program be dovetailed so that we may have available the use of these plants for future research.

We recommend, therefore, that your committee secure the advice of the Housing and Home Finance Agency as to the extent to which the provisions of S. 2816 and title II of S. 3557 are unnecessary because of the authority already conferred upon that agency by existing law.

The Bureau of the Budget has advised that there would be no objection to the submission of this report to your committee.

Sincerely yours,

FRED A. SEATON,
Secretary of the Interior.

[S. 3446, 86th Cong., 2d sess.]

A BILL To amend the Act of July 3, 1952, as amended, relating to research and development and utilization of saline water

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 2 of the Act of July 3, 1952 (66 Stat. 328), as amended (42 U.S.C. 1951 and the following), is hereby amended by adding a new subsection (f) which shall read as follows:

"(f) To negotiate contracts with any States, territories, possessions, political subdivisions or agencies thereof, or publicly owned utilities organization hereinafter called organization, for use of organization's saline water conversion plant facilities to further the sea and brackish water conversion research and demonstration programs authorized by this Act and the Act of September 2, 1958 (72 Stat. 1706)."

SEC. 2. Section 8 of said Act, as amended, is amended further to read:

"There are authorized to be appropriated such additional sums not exceeding $20,000,000 as may be required (a) to carry out the provisions of this Act during the fiscal years 1962 to 1967, inclusive, and (b) to finance for not more than two years beyond the end of said period such grants, contracts, cooperative agreements, and studies as may therefore have been undertaken pursuant to this Act, and (c) during the same additional period plus one more year to collate, coordinate, and round out the results and studies and research undertaken pursuant to this Act."

DEPARTMENT OF THE INTERIOR,
Washington, D.C., June 7, 1960.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

DEAR SENATOR MURRAY: This responds to your request for the views of this Department on S. 3446, a bill to amend the act of July 3, 1952, as amended, relating to research and development and utilization of saline water.

We recommend the enactment of this legislation.

It is the aim of this bill to extend the duration of and enlarge the authorization for the program being conducted by this Department's Office of Saline Water in order to expedite and assure the development of practicable, low-cost methods of producing from sea water, or from other saline waters, water of a quality suitable for industrial, municipal, agricultural, and other beneficial consumptive uses.

In the aid of accomplishing this objective, section 1 of the bill would modify the authority contained in the act of July 3, 1952 (66 Stat. 328), as amended by the act of June 29, 1955 (69 Stat. 198), by authorizing the Secretary of the Interior to enter into contracts with any State, territory, possession, political subdivision or agency thereof, or publicly owned utility organizations to permit the Office of Saline Water to conduct research on saline water conversion equipment owned and operated by any of those governments, agencies, or organizations.

During the period that S. 3446 would authorize the continued Federal program of research for and development of saline water conversion processes, it is anticipated that a considerable number of public entities charged with the responsibility of providing potable water for municipal or other uses will utilize converted sea or brackish water as their source of supply. Permitting the Secretary of the Interior to enter into contracts with such agencies for use of their equipment to attain specific research goals may obviate the necessity of constructing additional demonstration plants presently required to prove the reliability and commercial value of newly developed saline water conversion processes.

Substantial and encouraging progress in the search for low-cost conversion processes has been achieved through basic research and development programs sponsored by this Department's Office of Saline Water since the program was first authorized in 1952. Low-cost conversion, however, is a problem not yet satisfactorily solved. The research that has been conducted to date makes it increasingly clear that continued research is necessary if optimum economical processes are to be developed in time to meet our growing demands for the vital commodity. Already the city of Coalinga, Calif., has installed a conversion unit to provide its fresh-water supply. An indication of the widespread

interest in the potential of converted saline water is evidenced by the fact that over 175 cities and communities from every State on our coastal perimeter, except Delaware, from Alaska and Hawaii, and from 12 inland States have asked to be considered as a site for 1 of the 5 saline conversion demonstration plants authorized by the act of September 2, 1958 (72 Stat. 1706).

To permit the continuance of research in and development of low-cost conversion processes, section 2 of the bill would extend the present authorization for conducting this program to June 30, 1967, and it proposes further that the authorization of appropriations of such additional sums, not to exceed $20 million be approved for the extended 5-year period in order to accelerate the rate of development.

Beginning with laboratory research, the program has now moved into the pilot plant stage of processes development. While laboratory research to develop new processes is being continued, more pilot plants are needed to test and develop the results obtained from the fundamental research conducted in the laboratory.

The 1952 act, as it was subsequently amended, authorizes the expenditure of $10 million during the fiscal years 1953 to 1963, inclusive. Appropriations to the Office of Saline Water during fiscal years 1953 to 1960, inclusive, total $5,775,000. The budget request for fiscal year 1961 is $1,355,000, which is based on a pro rata share of the remaining authorization.

A special advisory committee appointed by the Secretary of the Interior to evaluate the progress of the work of the Office of Saline Water and make recommendations concerning future activities of the saline water conversion program has recommended that:

1. The duration of the saline water program should be extended beyond the existing authorization.

2. Basic and exploratory research should be expanded substantially, including coordination with other agencies which are concerned with such research.

We know that sea or brackish water can be desalted and put to beneficial use, but better processes are needed to make it an economical source of supply. Just prior to World War II, the cost of conversion ranged upward from $4 per thousand gallons. Today, plants around the world are producing about 20 million gallons of fresh water from the sea per day. The most efficient plant now in commercial operation is on the island of Aruba, just off the coast of Venezuela. This plant is producing 2.7 million gallons of fresh water per day at a cost of about $2 per thousand gallons.

Construction of demonstration plants authorized by the act of September 2, 1958 (72 Stat. 1706), will begin this summer. On the basis of extrapolations prepared by staff engineers of the Office of Saline Water we anticipate that at least two of these plants will produce fresh water for about $1 per thousand gallons. While these processes represent considerable progress, it is very unlikely that the conversion processes presently available for the demonstration plants are the best that can ultimately be developed. Further research is expected not only to improve those processes but it also holds promise of developing entirely new methods which may permit the attainment of a major breakthrough.

The results to date of this Department's saline water research and development activities under our basic authorization have in large part brought the technological advances that permit many communities in need of a dependable supply of fresh water to be interested now in the installation of conversion plants, if they could obtain the necessary financial assistance which any one of these bills would provide. It is our opinion that the continuation of the program which the bill would authorize should become of even more significance in making possible the bringing of good water supplies to local communities as a basis that was so economically feasible that the financing of the investment of substantial sums of money in conversion plants would be a less serious obstacle than it now is.

This Department and its Office of Saline Water have established a goal of producing fresh water from the sea for less than 40 cents per thousand gallons. Although many technological problems remain to be solved, results obtained from laboratory investigations give reliable indications that this objective can be attained. Water produced at this cost will make it sufficiently low to make it an important source of supplemental water for many areas of the United States and, indeed, of the world. Enactment of this bill is necessary if this important work is to be continued beyond June 30, 1963.

The Bureau of the Budget has advised that there is no objection to the submission of this report to your committee.

Sincerely yours,

FRED A. SEATON,
Secretary of the Interior.

[S. 2816, 86th Cong., 2d sess.]

A BILL To authorize loans for the design and construction of sea and brackish water conversion plants, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is the purpose of this Act to stimulate the construction of plants for the production, from sea water or brackish water, or water that is suitable for municipal or other beneficial consumptive uses, and thereby make miximum use of the research for the development and utilization of saline waters that was authorized by the Act of June 22, 1955 (69 Stat. 198), and maximum use of the demonstration program that was authorized by the Act of September 2, 1958 (72 Stat. 1706).

SEC. 2. (a) Any State, territory, possession, political subdivision or agency thereof, or publicly owned public utility organization, hereinafter called "organization," may submit to the Secretary of the Interior in such form as the Secretary may prescribe an application for a loan, or an offer to sell to the United States securities of the organization, to finance the design and construction of a plant to produce, from sea water or brackish water, water that is suitable for municipal, industrial, domestic, or other beneficial consumptive use.

(b) Such application shall include a showing (1) that the organization already holds or can acquire all lands and interests in land and rights, pursuant to State law, to the use of water that are necessary for the successful construction, operation, and maintenance of the plant; and (2) that the organization is ready, able, and willing to finance by other means the portion of the cost of design and construction that is not covered by the loan application or offer to sell securities.

(c) An application for a loan or an offer to sell securities may not be made in accordance with the provisions of this Act in an amount that exceeds 90 per centum of the estimated cost of design and construction (exclusive of land and water costs), or $1,000,000, whichever is smaller.

SEC. 3. (a) At such time as the Secretary approves an application or offer after finding that the construction is feasible and that the loan or purchase of securities would be a reasonable risk, he shall transmit to Congress the application or offer, his approval, and his findings.

(b) No appropriation shall be made for a loan to, or a purchase of securities from, the organization prior to sixty calendar days (which sixty days shall not include days on which either the House of Representatives or the Senate is not in session because of an adjournment of more than three calendar days to a day certain) from the date on which the Secretary's findings and approval are submitted to the Congress and then only if, within said sixty days, the Congress does not approve the application or offer by resolution.

SEC. 4. Either concurrently with the submission to Congress of an application or offer, or after the time for congressional disapproval has expired without the adoption of a resolution of disapproval, the Secretary may negotiate and execute an agreement with the organization which shall set out, among other things:

(a) The maximum amount of the loan or the securities to be purchased.

(b) The time and method for making the money available to the organization.

(c) A plan for the repayment of the loan in not more than forty years in periodic installments that need not necessarily be in equal amounts, and for the payment of interest on unamortized balances, beginning three months after the plant first commences operation, at a rate determined by the Secretary of the Interior by estimating the average annual yield to maturity, on the basis of daily closing market bid quotations or prices during the month of May preceding the fiscal year in which the loan is made, on all outstanding marketable obligations of the United States having a maturity date of 15 or more years from the first day of such month of May, and by adjusting such estimated average annual yield to the nearest one-eighth of 1 per centum at the beginning of the fiscal year preceding the date on which the agreement is executed; or, in the case of an

offer to sell securities, a plan of redemption that is consistent with the foregoing requirements with respect to a loan.

(d) Provisions for assuring and securing the prompt repayment of the loan and interest or for the redemption of the securities.

(e) Provisions making the liability of the United States under the agreement contingent upon the availability of appropriations for the purpose.

SEC. 5. Notwithstanding any other provision of law, the Secretary of the Interior is authorized to contract with a borrower under this Act for the use of the borrower's plant facilities to further the sea and brackish water research and demonstration programs authorized by the Act of June 22, 1955 (69 Stat. 198), and the Act of September 2, 1958 (72 Stat. 1706), and to provide in the contract for a credit on the organization's loan, or for a cancellation of its securities, in an amount up to 25 per centum of the original amount thereof that represents reasonable compensation to the borrower for the research and demonstration use made of his facilities.

SEC. 6. No loan or purchase of securities shall be made pursuant to this Act if the Secretary determines that in his judgment the organization can obtain funds on reasonable terms from other sources.

SEC. 7. There are authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act and all such appropriations shall remain available until expended.

DEPARTMENT OF THE INTERIOR,
Washington, D.C., June 7, 1960.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

DEAR SENATOR MURRAY: This responds to your request for the views of this Department on S. 2816, a bill to authorize loans for the design and construction of sea and brackish water conversion plants, and for other purposes.

We suggest that consideration should be given to the fact that the Housing and Home Finance Agency already has authority to make loans for community facilities. We also suggest amendments in the event Congress should, notwithstanding Housing and Home Finance Agency's existing authority, enact this legislation.

It is the aim of this proposal to assist and encourage cities and communities, faced with critical water supply problems, to take advantage of the research that has been conducted under the auspices of this Department's Office of Saline Water to develop lower cost saline water conversion processes by providing a program of Federal financial assistance for the purchase of the equipment necessary to produce potable water from presently unusable sea or brackish water sources.

In aid of accomplishing this objective, the bill would authorize the Secretary of the Interior to make a loan to or purchase the securities of any State, territory, possession, political subdivision thereof, or publicly owned utility for the purpose of assisting it in financing the design and construction of sea or brackish water conversion plants. The amount of Federal assistance could not exceed $1 million or 90 percent of the total cost (exclusive of the cost of land and water rights) of any one instalation, whichever would be the smaller. The amount of any such assistance would be repayable, with interest, in not more than 40 years. Such financial assistance could be made available only if the Secretary determines that funds could not be obtained from other sources on reasonable terms and that the loan or purchase of securities would be a reasonable financial risk.

Under the provisions of the bill, the Secretary would be required to transmit to the Congress, with respect to any application for assistance which he approves, the application for a loan or offer for the sale of securities, his approval and his findings thereon. No appropriation could be made, however, prior to the expiration of 60 days (excluding days during which the Congress is not in session because of adjournment for more than 3 calendar days) following the Secretary's submission to the Congress of his findings and approval, except that an appropriation may be made at an earlier date if the Congress should approve the application or offer by resolution prior to the expiration of said 60-day period.

Provision is made in the bill for the use of such plants by the Federal Government for further research and demonstration purposes and for giving a credit for

such use in an amount not to exceed 25 percent of the amount of Federal financial assistance under this bill.

Many cities now find it necessary to enlarge and increase the capacity of their water supply facilities to meet their growing domestic and industrial demands. For some, this expansion can be readily and economically achieved by drilling new wells or by increasing their withdrawal capacity from a nearby lake, stream, or river. Others will not be able to add to their present supplies so easily. In some areas new wells are not feasible because the present rate of withdrawal is rapidly lowering the underground water table. Continued heavy pumping by a number of coastal cities has reduced the water table so low that sea water is now beginning to infiltrate and pollute this major source of supply. A reduced rate of pumping wil be required to permit the natural recharge of these underground aquifers, completely ruling out the possibility of meeting increased demand from this source. Utilizing this source of supply from the time their municipal water systems were installed, many cities have assumed that local well water would be sufficient to meet all future demands. They did not, therefore, establish water rights on nearby surface waters, and now find that other public entities, private organizations or individuals, have established water rights and have preempted this source of supply.

Large metropolitan areas can afford to reach considerable distances to develop surface or underground sources of supply and, because of the volume involved, economically transport it to the water customers. For example, it was economically feasible for the water agency for the Los Angeles area to obtain municipal water supplies from the Colorado River, but it would be far beyond the ability of a city such as Tucson, Ariz., which is approximately the same distance from Parker Dam, to finance a project of such magnitude to obtain its municipal water supply.

Water is just as important to the citizens of a small community as it is to citizens of large cities, but many small cities are finding it increasingly difficult to locate sources of water that can be developed within the range of their financial capabilities. In many instances, these cities have already access to sea or brackish water and demineralizing this water with conversion units will provide the most economical and reliable source of supply to meet their municipal requirements.

Construction is scheduled to begin this summer on three saline water conversion plants. These plants should demonstrate to officials and citizens of interested cities and communities the reliability, economic feasibility, and engineering and operating potentials of various types of conversion processes. This legislation would complement the demonstration plant program by assisting cities and communities to bridge the gap between research and development and the practical application of saline water conversion processes. Further, by authorizing the Secretary of the Interior to contract with a borrower under this act for the use of the borrower's plant facilities to further the sea and brackish water conversion research and demonstration programs, it may obviate the necessity for expending Federal funds for the construction of future plants to demonstrate the reliability of new processes that are developed for commercial application.

Consideration should be given to the fact that the Housing and Home Finance Agency already has authority to make loans for community facilities, which we are informed includes the authority to make loans for saline water plants for community purposes. We feel the authority contained in this bill might appropriately be conferred upon the Housing and Home Finance Agency. We want to stress, however, the importance of the provision of section 5 of this bill which authorizes the Secretary of the Interior to provide a write-off of a portion of any Federal loan made for the development of the saline water plant in the event a community would permit us to utilize that plant in connection with our research and development program in saline water. It is highly important in our opinion that any loan program and the research program be dovetailed so that we may have available the use of these plants for further research.

We would suggest, therefore, that your committee secure the advice of the Housing and Home Finance Agency as to the extent to which the provisions of this bill might be unnecessary because of the authority already conferred upon that Agency by existing law.

In the event that the Congress sees fit to enact this legislation, we would recommend the adoption of the following clarifying amendments:

1. Substitute for the language appearing in lines 12, 13, and 14, page 3, the words "Congress unless, within said sixty days, the Congress approves the application or offer by resolution."

2. Substitute for the language appearing in lines 15 through 20, page 3, the following:

"Prior to making any loan pursuant to an application or purchasing any securities pursuant to an offer, the Secretary shall negotiate and enter into an agreement with the organization which shall set out, among other things:"

3. Substitute for the language appearing in lines 17 through 19, page 4, the following:

"(d) Provision for assuring the repayment of the loan, with interest, or for the redemption of the securities within the period provided in the contract."

The Bureau of the Budget has advised that there would be no objection to the submission of this report to your committee.

Sincerely yours,

FRED A. SEATON, *Secretary of the Interior.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., June 6, 1960.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: This is in reply to your letter of January 21, 1960, requesting the views of the Bureau of the Budget on S. 2816, a bill to authorize loans for the design and construction of sea and brackish water conversion plants, and for other purposes.

This bill has two principal objectives: (1) To stimulate the construction of sea and brackish water conversion plants by Federal loans to local public bodies for design and construction of such plants, and (2) to further research in saline water conversion processes by permitting the Secretary of the Interior to contract with local public bodies for the use of conversion plants financed with Federal lending assistance for research and demonstration purposes.

We have been advised by the Housing and Home Finance Agency that 40-year loans may already be made to qualified smaller municipalities for saline water conversion plants under title II of the Housing Amendments of 1955. While that Agency does not have any authority with respect to saline water research, we believe the research objectives of S. 2816 can be substantially accomplished by a separate research contract authorization for the Department of the Interior and appropriate coordination between the two Agencies. Under these circumstances, we would recommend against the creation of a new saline water loan program in the Department of the Interior as proposed in the bill.

We believe it would be desirable to give the Secretary of the Interior authority to contract for the use of non-Federal saline water conversion facilities for research and demonstration purposes. We would recommend, however, that this authority extend to facilities constructed by local public bodies without Federal assistance, as well as to those partly financed with Federal loans. Your committee has requested the views of the Department of the Interior on S. 3446, a bill to extend and enlarge existing authorizations for the saline water research program which would give the Secretary this general authority. We believe enactment of this legislation would meet the research objectives of S. 2816.

Accordingly, since the objectives of the bill can be substantially accomplished under the Housing Amendments of 1955 and the pending legislation referred to above, the Bureau of the Budget would recommend enactment of S. 3446 rather than S. 2816.

Sincerely yours,

(Signed) PHILLIP S. HUGHES,
Assistant Director for Legislative Reference.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
June 13, 1960.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This letter is in response to your request of January 21, 1960, for a report on S. 2816, a bill to authorize loans for the design and

construction of sea and brackish water conversion plants, and for other purposes.

The bill would provide that—

(1) Any State, territory, possession, political subdivision or agency thereof, or publicly owned public utility organization may apply to the Secretary of the Interior for a loan, or may offer to sell its securities to the United States, to finance the design and construction of a conversion plant;

(2) The loan or purchase of securities may not exceed 90 percent of the cost of design and construction or $1 million, whichever is smaller;

(3) Approved applications shall be transmitted to the Congress, and if, within 60 days, the Congress does not disapprove the application or offer by resolution, an appropriation for the loan may be made (the word "approve" in the bill instead of "disapprove" is assumed to be a typographical error, since the context requires "disapprove" and the identical bill in the House, H.R. 9641, contains the word "disapprove");

(4) The loan must be repaid within 40 years at a prescribed interest rate;

(5) The Secretary is authorized to contract for the use of the borrower's plant for research and demonstration to be compensated by a credit of up to 25 percent of the loan; and

(6) Necessary sums to remain available until expended are authorized to be appropriated.

This Department is concerned, from the public health standpoint, with municipal, domestic, and related water-supply needs. However, the Secretary of the Interior would have primary responsibility for administering the provisions of the bill and, therefore, we defer to his views as to the desirability and need for enactment of this legislation.

The Bureau of the Budget advises that it perceives no objection to the submission of this report to your committee.

Sincerely yours,

ARTHUR S. FLEMMING, *Secretary.*

Senator ANDERSON. I shall insert in the record a copy of a news release issued on May 26, which outlines my views. The distinguished majority leader of the Senate is the chief sponsor of S. 3557 and the 20 cosponsors are listed.

(The news release follows:)

[News release from Committee on Interior and Insular Affairs, May 26, 1960]

Senator Clinton P. Anderson, Democrat, New Mexico, chairman of the Subcommittee on Irrigation and Reclamation, Senate Committee on Interior and Insular Affairs, today announced hearings on Wednesday, June 8, on S. 3557, a bill to expand and extend the saline water conversion program under the Department of the Interior. The hearings will open at 10 a.m. in room 3110, New Senate Office Building.

S. 3557 is sponsored by Senator Lyndon B. Johnson, of Texas, with 20 cosponsors, including Senator Anderson. The other sponsors are Senators Kuchel, Moss, Symington, Allott, Jackson, Kerr, Smathers, Case of South Dakota, Humphrey, Javits, Yarborough, Murray, Gruening, Carroll, Church, Clark, Mansfield, McGee, Williams of New Jersey, and Monroney.

In announcing the date of the hearings, Senator Anderson asserted a main objective of the bill was to accelerate the interest and concern of the Senate to expedite the saline water program which he has pressed since 1952 when the initial legislation was approved by the Congress.

"As a cosponsor of the original saline water conversion program, I am anxious to see the program pushed ahead in every possible way," Senator Anderson said. "The Department of the Interior has moved forward on the program, but every agency needs to recognize the urgency of saline water demonstration programs.

"I favor research but we must all insist that demonstrations of proven conversion processes be pressed to show whether theories and promising techniques can be proved or disproved. Progress has been made toward reducing conversion costs both as to sea water and brackish water. However, we want to be able to express in simple, understandable terms what has been achieved.

"The subcommittee will be glad to have any information or comments from Government or other agencies on the subject, and particularly with respect to

the needs for the program and progress that is being made toward achievement of the objectives."

Senator ANDERSON. Because of the time element, the number of witnesses today, including representatives of the Department of the Interior, is limited. Statements, however, may be filed for the record.

First, I shall insert in the record the contents of a booklet on "The Facts About Salt Water Conversion," prepared by the Research and Education Committee for a Free World, of which David Lloyd is director.

This publication reveals exceedingly valuable information that contributes to an understanding of the problem. It was prepared under the direction of Mr. David Lloyd.

I also wish to insert in the record a news release dated June 3 from the Department of the Interior that San Diego has been selected as the site for nonnuclear west coast saline water conversion demonstration plant.

(The booklet and news release follow:)

THE FACTS ABOUT SALT WATER CONVERSION

AN URGENT NEED

We are rapidly reaching the limits of our available fresh water supply. The only remaining additional sources are salt and brackish waters. When we reach the point where available fresh water cannot meet our needs, expansion and growth of people, cities, farms, and industry will cease.

The Federal Government has spent billions on atomic energy research and only a few millions on saline water conversion research. The need is great that this program be developed with a sense of urgency commensurate with its importance to our own economic growth and the possibility it offers of improving conditions of mankind throughout the world. Foreign countries in arid regions suffer from drought and water shortages far beyond anything one can conceive of in the United States. Many of these nations have access to the sea or vast resources of presently unusable brackish water. The effect of a practical low-cost saline water conversion process on the economies of these countries would be revolutionary.

The Report of the House Committee on Government Operations, published August 12, 1958, contains the following recommendation: "The Office of Saline Water must substantially increase its efforts in advancing both basic research and pilot plant work in the saline water conversion program. Such effort would be facilitated by amendment of the Saline Water Act to eliminate the financial authorization restrictions now present in that act and by appropriation of sufficient additional sums to enable such work to proceed promptly and without deferment."

This congressional recommendation is urgent. To date it has not been implemented.

I. OUR FRESH WATER RESOURCES AND NEEDS

What are the main sources of water for municipal, industrial, and agricultural use in the United States today?

There are two principal sources of water that can be developed for general use—surface and underground. Surface supplies are obtained from rivers, lakes, and manmade reservoirs that are supplied by rainfall and melting snow. Part of the rainfall percolates into underground pools or aquifers, from which it can be pumped for various uses. An aquifer is a water-bearing stratum of earth, gravel, or porous stone.

What is the total rainfall in the United States?

The average daily rainfall in the United States is estimated at about 4,300 billion gallons. Precipitation ranges from an average of 51.2 inches in the South Atlantic States to 10.3 inches per year in the arid areas of the Southwest.

Most of the Nation receives an average of 30 inches of rainfall per year.

What percent of the total rainfall is available for use?

Losses through evaporation and transpiration drastically reduce the amount of runoff water that can be collected and put to beneficial use.

On the west coast, for example, of a total average rainfall of 26.7 inches, approximately 10½ inches are lost due to evaporation, and 6.9 inches are lost in transpiration, leaving only 9.3 inches to become runoff. And not all of this 9.3 inches can be used. Losses through evaporation (water returned to the atmosphere by the heat of the sun) and transpiration (water used in the life cycle of all plants and passed to the atmosphere from the foliage) drastically reduce the amount of water remaining which can be collected and put to use.

Further depletion of the available natural supply is caused by natural and manmade pollution.

There remains an available fresh-water supply of some 515 billion gallons daily, of which we are at present using some 312 billion gallons daily.

Is our annual water consumption increasing?

The table shown below indicates that in the year 1900 our total daily water use was 40 billion gallons. In 1940, the daily use had more than tripled to 135 billion gallons, and it is estimated that in 1960 the total use will be 312 billion gallons daily.

Estimated U.S. water use

[In billions of gallons daily average]

Year	Irrigation [1]		Public water supplies		Domestic [2]		Self-supplied use industrial and miscellaneous [3]		Steam electric power		Total water use	
	Pumped from underground	Total	Pumped from underground	Total	Pumped from underground	Total	Pumped from underground	Total	Pumped from underground	Total	Pumped from underground	Total
1900	2	21	1	3	2	2	1	10	0.2	5	7	40
1910	6	39	1	5	2	2	2	14	0.2	6	11	66
1920	8	56	2	6	2	2	2	18	0.2	10	15	92
1930	9	60	2	8	3	3	2	21	0.4	18	17	110
1940	10	71	3	10	3	3	3	29	0.4	22	20	135
1944	12	81	3	12	3	3	6	56	0.7	36	25	188
1945	13	85	3	12	3	3	5	48	0.5	29	25	175
1946	14	86	3	12	3	4	4	39	0.5	27	25	168
1951	18	100	4	14	4	5	5	46	0.7	38	31	203
1955	25	120	4	17	5	5	6	60	1.0	60	41	262
1960	29	135	5	22	6	6	7	72	1.2	78	48	312
1965	33	148	6	25	6	6	8	88	1.4	92	55	359
1970	38	159	6	28	7	7	10	102	1.5	108	62	405
1975	44	170	6	30	7	7	10	115	1.8	131	69	453

[1] Total take, including delivery losses but not including reservoir evaporation.

[2] Privately supplied fresh water from cisterns, wells, creeks, etc., for farm and nonfarm domestic uses, and water for farm stock.

[3] Manufacturing industry, mineral industry, commercial, air conditioning, resorts, motels, military, and miscellaneous.

Source: Water and Sewerage Industry and Utilities Division, BDSA, Department of Commerce.

How much will our water requirements continue to increase in the future?

The U.S. Department of Commerce estimates the following increases:

	Billion gallons per day
1960	312.45
1965	359.47
1970	404.51
1975	453.08

How big is 312 billion gallons?

Three hundred and twelve billion gallons would cover approximately 876,960 acres of land with 13 inches of water. In other words, enough water to cover the entire State of Rhode Island with more than 1 foot of water.

What are the major uses of fresh water?

At the present time, industrial plants use roughly 40 percent of the total available supply of fresh water, agriculture uses roughly 50 percent, and municipal and domestic use accounts for the remaining 10 percent.

Will natural water supplies be adequate for our increasing population and economic demands?

The U.S. Geological Survey has estimated that the total readily available supply of fresh water in the United States is 515 billion gallons daily. This year, 1960, with a population of 180 million and a gross national product of $440 billion,[1] calculated at 1954 prices, we are using an estimated 312 billion gallons daily, or 60 percent of the total available supplies. Even with this ratio of 5 supplies to 3 consumption, there are today severe water shortages in many parts of the country because water supplies are very unevenly distributed.

Natural fresh-water supply remains constant, but 15 years hence—in 1975—our population will have grown to 235 million and our gross national product, according to the most conservative estimate, to $728 billion, reflecting a vast expansion in water-using population and industry. In 1975 we will be using an estimated 453 billion gallons of fresh water daily, or 88 percent of available supplies. As consumption approaches the total supply available, local and regional shortages will become increasingly widespread and severe.

We would need available fresh-water supplies of 755 billion gallons daily in 1975 if we were to maintain the 1960 ratio of 5 supplies to 3 consumption. Obviously, this is about 32 percent more than will be available from natural sources.

The following table shows the actual and the estimated increases:

Growth in the United States

Year	Total water use [1] (billion gallons per day)	Population [2]	GNP [3] (billions)
1900	40	75,994,575	[4] $18.6
1940	135	131,669,275	205.8
1955	262	164,302,000	392.7
1960	[5] 312	180,100,000	440.0
1975	[5] 453	235,200,000	728.0

[1] BDSA—Department of Commerce.
[2] U.S. Bureau of Census.
[3] U.S. Department of Commerce—figures adjusted to value of dollar in 1954.
[4] National Bureau of Economic Research.
[5] Estimated.

Are there areas of the United States actually suffering from lack of water?

Texas and southern California, Arizona, New Mexico, suffer annual water shortages. Nationally, 1,000 cities and communities throughout the United States were forced to restrict the use of water in 1957, according to a study conducted by the U.S. Geological Survey.

The study indicated 15 out of every 100 persons in the United States were forced to curtail their normal use of water. In 1957, water shortages were prevalent in 47 States. During this period, residents of Dallas, Tex., queued up to purchase water at 50 cents per gallon—double the local price for gasoline.

Do we lower the natural water table by pumping from underground aquifers?

Pumping water from underground reservoirs may lower the water table in some underground aquifers if the rate of withdrawal is greater than the natural recharge of the aquifer. If the water table is lowered in areas adjacent to

[1] Gross national product is used here as an indicator of industrial and other economic activity which impinges directly upon water supplies.

sea water, the sea water may seep into the aquifers. This has happened in parts of Long Island and New Jersey, and at a large number of places along the Atlantic and gulf coasts.

In the last analysis the oceans are the only unlimited water resource, especially since they are also, by evaporation, the source of all rainfall.

What are agriculture's water needs?

At the present time, agricultural uses of water account for approximately 50 percent of the total water use. This does not of course include rainfall directly absorbed on crops and pastures.

As population expands in the more arid parts of the country, water requirements for irrigation steadily increase.

Grains take over 650,000 gallons per acre to produce a crop. An acre of alfalfa needs over 1 million gallons per season. To produce a single pound of beef for the dining room table requires 3,750 gallons of water. A single slice of bread requires 37 gallons of water.

A review by the Bureau of Reclamation in 1954 pointed out that in California and Texas alone there was a potential need for over 21 million acre-feet annually (an acre-foot equals 326,000 gallons) over and above the need which could be supplied by natural local water.

Which industries require large quantities of water for their operation?

Industrial plants use about 40 percent of all the water used in the United States at the present time, and industrial use is growing enormously.

The mining industry, as well as the chemical, plastics, and pharmaceutical industries are especially heavy users of water. Every person employed in an electrometallurgical plant uses 22 million gallons a year, on the average, in the performance of his job. Some chemical plants require 17 million gallons of water annually for each man on the payroll. Industrial requirements for water are placing a tremendous demand on the total available supply.

To manufacture 1 ton of acetate or 1 ton of newsprint requires as much as 240,000 gallons of water. To process a single ton of steel requires as much as 60,000 gallons of water. To produce a ton of synthetic rubber requires about 660,000 gallons of water.

What are some of the military and civilian defense needs for converted water?

The U.S. Navy provides saline-water converters on all major ships. Carriers of the *Forrestal* class, for example, are equipped with four 50,000 gallon per day conversion units. The cost of producing water for Navy and military uses ranges from $2 to $4.50 per thousand gallons.

Crews of the atomic submarines *Nautilus*, *Skate*, and *Seawolf* drink water converted by heat from their atomic reactors.

In military use, where the emphasis is on a reliable source of supply, the cost of conversion is of secondary consideration. During World War II Marine and Army troops on Iwo Jima, Saipan, and other Pacific islands were supplied with fresh water by conversion units.

In civil defense programs, sea-water distillation processes can remove radioactive contamination from water and may prove to be a major source of fresh water for our civilian population in the event of an atomic attack.

In flood disaster areas mobile conversion units could be developed for use where water supplies have been contaminated. Self-contained units could produce fresh water to meet emergency demands until regular facilities were put back into use.

How much water does a 400-bed hospital use daily?

A 400-bed hospital, according to U.S. Public Health Service, requires 250 gallons per bed each day or a total of 100,000 gallons daily.

A 20-story office building?

A 20-story office building with 200 persons per floor requires 120,000 gallons per day.

A 15-story apartment building?

A 15-story apartment building housing 1,000 people in 300 apartments requires 50,000 gallons per day.

A one-family house?

A 1-family house in which 4 people are living requires an average total of 550 gallons per day.

How much water is used daily in cities throughout the United States of America?

[From "A Summary of Operating Data for Water Works in 1955" Journal of the American Water Works Association—May 1957][1]

City and State	Population served [2]	Average gallons per day [3]
Aberdeen, S. Dak	23,000	2,392,000
Albany, N.Y	135,000	24,097,000
Atlanta, Ga	540,000	55,468,000
Austin, Tex	200,000	31,963,000
Billings, Mont	60,000	8,853,000
Bismarck, N. Dak	23,000	2,278,000
Cleveland, Ohio	1,460,000	309,714,000
Denver, Colo	614,000	56,088,000
Des Moines, Iowa	219,000	93,784,000
Indianapolis, Ind	517,000	62,172,000
Jefferson City, Mo	28,000	1,409,000
Lincoln, Nebr	126,000	20,023,000
Little Rock, Ark	201,000	17,150,000
Madison, Wis	123,000	14,459,000
Miami, Fla	500,000	72,967,000
Nashville, Tenn	304,000	31,500,000
New York, N.Y	7,650,000	1,093,500,000
Oklahoma City, Okla	299,000	27,739,000
Phoenix, Ariz	216,000	42,584,000
Pittsburgh, Pa	650,000	93,784,000
Portland, Oreg	650,000	75,600,000
Reno, Nev	55,000	21,232,000
Richmond, Va	264,000	26,114,000
Sacramento, Calif	163,000	38,466,000
Seattle, Wash	648,000	84,107,000
Salt Lake City, Utah	247,000	95,542,000
St. Paul, Minn	339,000	38,520,000
Springfield, Ill	110,000	14,126,000
Tampa, Fla	235,000	21,737,000
Santa Fe, N. Mex	33,000	3,140,000

[1] Latest available figures.
[2] Combined wholesale and retail population served.
[3] Computed from yearly production divided by 365.

What are today's water rates?

Water rates vary widely in the United States, but most municipal supplies are priced to the consumer at between 25 and 40 cents per thousand gallons. However, in most cases municipal water rates bear little relation to cost.

What is the true cost of municipal water today?

This is extremely difficult to answer, for several reason:

1. Costs vary widely, according to location.

2. Most municipal water facilities were constructed from 20 to 40 or more years ago when construction costs were far lower than now.

3. In most instances the capital investment for the development of natural water supplies has been covered in general obligation bond issues without affecting the water rate.

4. Although there is a standardized procedure for calculating saline water conversion costs, there is none for estimating the cost of water from natural sources of supply.

5. In most cities the cheapest and most readily available sources of water have already been developed, and cities are being forced to go ever-greater distances at ever-increasing cost to develop additional sources of fresh water to meet their growing needs.

Can the cost of converting saline water be compared with the cost of developing natural water supplies?

In individual cases, yes, after careful survey and provided all the costs of developing new natural water supplies are included.

Comparisons could be made with greater accuracy, reliability, and economy if there were a standardized procedure for estimating the cost of water from natural sources. Such a standardized procedure could and should be developed for use of communities throughout the country facing a need for enlarging their water supplies.

In general, the costs of converting saline water should be compared not with today's water rates, or even today's water costs, but with the cost of tomorrow's

water, for the population is growing, costs of natural water are increasing, and natural water supplies are limited.

II. THE SALINE WATER CONVERSION STORY

What is "saline water"?

The term "saline water" is used to designate water that is generally considered unsuitable for human consumption or for irrigation because of its high content of dissolved solids in quantities exceeding those set by the U.S. Public Health Service (1946) for drinking water.

There are three categories of saline water:

1. Brackish water, which ranges upward from 1,000 parts of dissolved salts per million parts of water.
2. Sea water, which generally contains 35,000 dissolved parts of salt per million parts of water.
3. Brine, which is any water containing more dissolved salts than sea water. Water in Great Salt Lake, for example, contains about 200,000 dissolved parts of salt per million parts of water.

The specific terms used in describing the salinity of water are as follows:

Description	*Dissolved solids in parts per million*
Slightly saline (brackish)	1,000– 3,000
Moderately saline (brackish)	3,000–10,000
Very saline (sea water)	10,000–35,000
Brine	35,000 plus

The "slightly saline" category includes many natural surface and underground water supplies that are currently in use or are potentially useful.

Where is saline water found?

Three-fifths of the globe is covered by oceans that contain an estimated 320 million cubic miles of saline water.

Preliminary surveys conducted by the U.S. Geological Survey have located vast quantities of both surface and underground brackish water in the United States. Brackish water is known to exist in large quantities in many other parts of the world.

How much of the United States and its principal industrial areas are accessible to sea coasts and sea water?

Twenty-four of our States are on the coast of an ocean. These States contain 65 percent of our industry and 55 percent of our population.

Is it possible to remove the dissolved salt from saline water?

For over two centuries man has been able to extract fresh water from saline water by simple distillation processes, that is, by boiling saline water, and collecting and condensing the resulting steam into pure water. This is an effective but costly and time-consuming method of obtaining water from the sea.

What are the methods now used for converting saline water into fresh water?

Basically there are only two ways to convert saline water:

1. Take the water out of the salt (distillation and freezing).
2. Take the salt out of the water (membrane [electrodialysis]).

The processes being used or are under development are:

1. Distillation.—Through artificial heat. This is the age-old process of boiling water. Improvements in heat transfer and scale and corrosion control are reducing the cost of producing fresh water by distillation. Artificial heat used in any distillation process is provided by the cheapest fuel availabel at the plant site, such as oil, natural gas, coal, or atomic energy.

2. Solar distillation.—Which uses the heat of the sun to vaporize the water.

3. Membrane processes (electrodialysis).—Which use a combination of thin membranes and electric current to screen out the dissolved salts.

4. Freezing.—An ice crystal is pure water, but when sea water is frozen the salt crystals are trapped between the ice crystals. Methods of separating the two are now under intensive development.

5. Other.—Chemical and electrical methods of conversion, such as gas hydrates and controlled absorption, are under research study.

What are the limitations of these methods?

In saline water conversion the only present limitation is cost. Principal items of cost are capital investment, fuel, maintenance, and operating expenses. Fresh water can now be obtained from sea and brackish water sources but it is relatively expensive water. The high cost of conversion can be decreased only through further research for the development of lower cost conversion processes. Continued technological progress will remove the present economic limitations.

What is the cost of conversion by these various methods§

1. The most efficient plan now in operation is on the island of Aruba, a Caribbean island in the Netherlands West Indies. It is producing fresh water from the sea by a submerged tube distillation process for about $1.75 [2] per thousand gallons.

The Office of Saline Water is planning to build a 1 million gallon per day sea water conversion plant at Freeport, Tex., using a newly developed long-tube vertical multiple-effect distillation process, which is expected to produce fresh water for about $1 [2] per thousand gallons. Engineering projections indicate that if this process were built on the scale of 15 to 20 million gallons per day it would produce fresh water for about 50 cents [2] per thousand gallons.

2. While the energy for solar distillation is free, the cost of capital equipment required to collect the diffuse free energy is so large that water obtained by this process costs about $2 [2] per thousand gallons.

3. Membrane processes (electrodialysis) may soon be able to convert brackish water to fresh for somewhat less than 50 cents [2] per thousand gallons.

4. Freezing processes are so new that little data has yet been obtained, but laboratory tests indicate they will be competitive with the best distillation processes.

Are all processes competitive at various production levels or capacities?

Some processes lend themselves to medium range production (100,000 to 500,000 gallons per day), while other processes reach maximum efficiencies in multimillion gallon per day plants.

Membrane processes reach maximum efficiency on brackish water.

Efforts are also being made to develop very small conversion units to meet the demand of an individual home (1,000 to 5,000 gallons per day).

Continued research is expected to reduce the cost of conversion below 50 cents per thousand gallons. At this point, it will approach competitiveness in many areas with natural water.

Do we diminish natural water resources by the converison of saline water?

Quite the contrary. The conversion of saline water to fresh will supplement our existing supplies of natural fresh water.

Do you pollute natural water resources as a consequence of the conversion process?

No. There is a possibility that disposition of the brine may present a problem at some inland locations, but studies indicate that this problem can and will be overcome wherever it arises.

Is the desalted water fit for drinking, or is it just good enough for agricultural or industrial use?

Fresh water distilled from saline water is a high quality, pure water especially desirable for drinking water or other domestic uses. Water of this high quality is frequently required for specialized industrial uses.

Is the conversion process the same for sea water as for brackish water?

Converison processes can remove salts from both sea and brackish water. Some processes have been developed that will remove the salt from brackish water at lower cost than from sea water, but they are not competitive with other processes for removing salt from sea water.

Are there any saline water conversion plans now used in industry anywhere in the world?

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[2] All these costs are computed by the U.S. Department of Interior standardized procedure for estimating saline water conversion costs.

Typical large land-based distillation plants (over 100,000 gallons per day)

[Explanation of symbols: A, agricultural; D, domestic; I, industrial]

Location	Purchaser	Total installed capacity (gallons per day)	Type of plant	Use	Manufacturer
Al Kuwait, Kuwait (Persian Gulf)	Government of Kuwait	2,500,000	Distillation	D-I	Weir & Westinghouse.
Al Kuwait, Kuwait	do	2,500,000	do	D-I	Westinghouse.
Balashi, Aruba (Caribbean)	Government of Netherlands, Antilles	3,500,000	do	D-I-A	G. & J. Weir.
Willemstad, Curacao (Caribbean)	do	1,000,000	do	D-I	Do.
Nassau, Bahamas	British Electric Co	1,200,000	do	D-1	Do.
Las Piedras, Venezuela	Creole Oil Co	450,000	do	I	Griscom-Russell.
Kinney AFB (Bermuda)	USAF	225,000	do	D	Cleaver-Brooks.
Thule AFB (Greenland)	do	130,000	do	D	Mechanical Equipment.
Dharan AFB (Arabia)	do	200,000	do	D	Cleaver-Brooks.
Pacific Gas & Electric (Morro Bay, Calif.)	Pacific Gas & Electric	150,000	do	I	Lummus Co.
Arrowhead & Puritas Co. (Los Angeles, Calif.)	Arrowhead & Puritas	100,000	do	I	Cleaver-Brooks.
Gibraltar (the rock)	British Government	200,000	do	D	Do.
Mirafiori, Italy	Societa Italiana Ernesto Breda	300,000	do	I	Escher-Wyss.
Buenos Aires, Argentina	Delulosa Argentia, S.A.	150,000	do	I	Do.
Marcus Hook, Pa	New Jersey Public Service Co	300,000	do	I	Westinghouse.
Government of Ecuador (Salinas)		100,000	do	D-I	Cleaver-Brooks.
Union of South Africa, Welkom, Orange Free State	Anglo America Corp	2,800,000	Electro-dialysis (membrane).	I	SACSIR.

What is standardized procedure for estimating saline water conversion costs?

Standardized procedure was developed in 1956 by the Office of Saline Water to provide a guide for comparing conversion costs of the various processes. The procedure recognizes all costs including land, capital investment, operating costs, maintenance, interest, insurance, taxes, and a rather severe 20-year amortization period. The procedure has worldwide acceptance as a proper gage for comparing the economic potential of the various saline water conversion processes.

Is converted saline water being used for agriculture?

We know of no area where converted water is being used commercially for agricultural purposes. There is a small experiment being conducted in Aruba, a Caribbean island in the Netherlands West Indies, in hydroponic farming. (Hydroponic means growing plants in water containing the essential mineral nutrient salts, instead of in soil.) The price of vegetables thus produced is less than those shipped in, but this type of farming is still not commercially feasible. Irrigation projects in California and throughout the world, however, have demonstrated the enormous benefits of bringing water into arid regions at costs low enough to warrant it.

Is converted saline water being used by municipalities?

The city of Coalinga, Calif., is the first city in the United States to provide its citizens with drinking water converted from brackish well water at a cost of $1.45 per thousand gallons. The cost of hauling water into the city was $7.25 per thousand gallons; delivered to the consumer, the cost was $9.35 per thousand gallons.

What are the alternatives to saline water conversion?

The alternatives to saline water conversion are limited and also expensive. The Federal Government seeks to conserve and develop our available supplies of fresh water through construction of dams and reservoirs (by the Bureau of Reclamation and the Corps of Engineers), conservation practices and programs (of the Department of the Interior and the Department of Agriculture), pollution control, industrial reuse of water, reclaiming of sewage.

There are physical and practical limitations to all of these programs of basic conservation. Construction of dams and reservoirs is limited by available landsites and surface water. Pollution control and industrial reuse do not increase the available supply.

The saline water conversion program is the only program not limited by the fact that there is only a fixed amount of fresh water available. In spite of every effort to obtain maximum use of fresh-water supplies, additional sources of water will be needed to meet the predicted demand of the next two decades.

III. THE OFFICE OF SALINE WATER: PROGRAM, COSTS, NEEDS

What is the role of the U.S. Department of the Interior?

As the foremost conservation agency of the Federal Government the Department of the Interior is vitally concerned with the conservation, development, and use of the natural resources of the Nation. Water, a basic natural resource, is the object of many of the Department's conservation and development programs which include activities conducted by the Bureau of Reclamation, Geological Survey, Bureau of Mines, Bureau of Land Management, and the Office of Saline Water.

Under what authority does the Office of Saline Water operate?

In view of the acute shortage of water in the arid areas of the Nation and elsewhere, and the excessive use of underground waters throughout the Nation, President Harry S. Truman, in March 1950, requested the Secretary of the Interior and the heads of several other Federal departments and agencies to seek information and legislation on the large-scale conversion of salt water. Congress, in 1952, enacted Public Law 448, 82d Congress, to provide for research into and development of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes. The act established the Office of Saline Water under the Department of the Interior and authorized $2 million for a 5-year (fiscal 1953–58) period to carry out the provisions of the law.

In 1955, Congress amended the 1952 act (Public Law 111, 84th Cong.) by increasing the total authorization from $2 million to $10 million, providing for the research, development, and construction costs of pilot plants, and extending the life of the program from fiscal 1953 through fiscal 1963. If this program is to continue to function effectively, even on its present modest basis, it must very soon be officially extended by Congress and more money authorized, for operations must be planned and contracts let several years in advance.

On September 2, 1958, President Eisenhower approved Public Law 883, 85th Congress, which provides a second $10 million authorization for the construction and operation of at least five saline water conversion demonstration plants to test and demonstrate the reliability, and the engineering, operating, and economic potentials of sea- or brackish-water conversion processes.

The law provided that at least three of the plants be designed for the conversion of sea water, and that each of two plants so designed shall have a capacity of not less than 1 million gallons per day. At least two of the plants are to be designed for the treatment of brackish water, and at least one of these plants shall have a capacity of not less than 250,000 gallons of fresh water per day. One of the sea-water plants is to be located on the east coast, one on the west coast, and one on the gulf coast. One of the brackish water plants is to be located in the northern Great Plains and the other in the arid areas of the Southwest.

What is the difference between a pilot plant and a demonstration plant?

A pilot plant is a small research facility designed to test and develop new or improved saline water conversion processes.

A demonstration plant is designed as a production unit, with much larger capacity than a pilot plant, to provide data on reliability, engineering, operating, and economic potential of a conversion process.

Where are pilot plants now actually functioning?

The Office of Saline Water has two distillation research facilities operating at Harbor Island, Wrightsville Beach, N.C.; and one at the Batelle Memorial Institute, Columbus, Ohio. Four electrodialysis units are under test at the Bureau of Reclamation Laboratories, Denver, Colo. A 15,000 gallons per day freezing-process pilot plant is in operation at the Carrier Corp. plant, Syracuse, N.Y. Three solar distillation pilot plants are under development at Daytona Beach, Fla.

Pilot plant activity began in fiscal 1955. The Office of Saline Water now has 11 pilot plants in operation and several more are now in the planning stage.

Where will the demonstration plants be located?

1. The first demonstration plant, which will utilize the long-tube vertical multiple-effect distillation process, will be located at Freeport, Tex. The plant will be designed to produce fresh water from the sea at an anticipated rate of at least 1 million gallons per day. It is scheduled to be completed in the spring of 1961.

2. The second plant will be located at San Diego, Calif. Utilizing a process known as multistage flash distillation, this plant will also be designed to produce fresh water at the rate of 1 million gallons per day. The energy (heat) required to operate this plant will be provided by the Atomic Energy Commission from an experimental low-temperature low-pressure atomic reactor. It is scheduled to be completed in the summer of 1961. In this connection it should be noted that the Office of Saline Water has completed a preliminary design study of an optimum (50 million gallons per day) nuclear reactor sea water distillation process which indicates a production cost of potable water, in a 52-stage flash evaporator, of 42 cents per thousand gallons. This study indicates that one of the most important peaceful applications of atomic energy may be for the production of low-cost fresh water from the sea.

3. The membrane (electrodialysis) process is the process selected for a third demonstration plant operation. It is to be located at Webster, S. Dak. Designed to produce 250,000 gallons per day, it is scheduled for completion in 1961.

4. The fourth process is forced circulation vapor compression distillation. This plant is to be located at Roswell, N. Mex., and will be designed to convert brackish water to fresh at an anticipated rate of at least 250,000 gallons per day. It is scheduled to be completed in 1962.

5. The fifth process for demonstration plant programing will be a freezing process. It will be located on the east coast, and is expected to be in operation in 1962.

Scientists and engineers generally agree that the final answers to low-cost saline water conversion will not be found in these plants, and that considerably more research, development, and demonstration will be required.

Processes and sites for additional demonstration plants, beyond these five, have not been selected.

Have individual States shown an interest in the saline water conversion program?

Seven States—California, New Mexico, Texas, Arizona, Florida, North Carolina, and South Dakota—have entered into agreements with the Department of the Interior for mutual assistance and exchange of information in the study of saline water conversion processes. Other States are expected to sign similar agreements. Many States have shown an interest in developing joint financial contributions for study projects.

California (with a $1,600,000 current appropriation) is the only State which has developed a joint financial support (State 40 percent, Federal 60 percent) program for research and for building a demonstration plant showing the feasibility of using nuclear energy in saline water conversion.

The University of California is also sponsoring a program of sea-water conversion, with special emphasis on the uses of nuclear energy in saline water conversion.

New Mexico has also entered into a cooperative agreement with the Department of the Interior for the exchange of information on the development of improved saline water conversion processes and their actual or potential application. Assistance provided by the State under the terms of this agreement was helpful in obtaining data needed for the selection of a site for the saline water conversion demonstration plant authorized for that area. The New Mexico Legislature has appropriated $100,000 for State participation in the construction of the demonstration plant.

How is the Office of Saline Water financed?

The Office of Saline Water operates on two $10 million authorizations.

1. One is for research and development and this authorization will terminate in 1963. The research and development budget includes salaries for office personnel as well as the funds for research and the construction of pilot plants. In the 8 years from fiscal 1953 through fiscal 1960, a total of $5,788,000 will have been spent on this program. This leaves a balance of $4,212,000 or a little less than $1,500,000 a year for the remaining authorized years of operation from fiscal 1961 through fiscal 1963.

2 The second $10 million authorization is for the construction of demonstration plants and this authorization will terminate in 1965. This budget includes the construction of at least five plants and the operational funds required for plant operation. A total of $1,850,000 has been appropriated through fiscal 1960 for this program, leaving an unappropriated balance of $8,150,000. The five plants currently planned will use about $6 million of the authorized funds.

What is the total personnel of the Office of Saline Water?

There are 25 employees in the Office of Saline Water.

The report of the House Committee on Government Operations published August 12, 1958, states that: "The Office of Saline Water is substantially understaffed with resulting excessive workload and impairment of its efficiency and ability to advance the saline water program as rapidly as Congress intended."

What is the budget request of the Office of Saline Water for fiscal 1961?

Fiscal year 1961 budget request

1. Research and development:	
Basic exploratory research	$250,000
Distillation processes	275,000
Solar processes	100,000
Membrance processes	150,000
Freezing processes	225,000
Other processes, evaluations, and surveys	135,000
Total	1,135,000
Administration (salaries) and coordination of programs	220,000
Total	1,355,000
2. Construction of demonstration plants	2,040,000
Total	3,395,000

Are the funds authorized for the Office of Saline Water sufficient to allow it to expand and accelerate its program?

The Office's present $10 million authorization for research and development will be completely expended by 1963. Unless Congress enacts new legislation, this vital program will end on June 30, 1963.

Under the existing authorization it is impossible for the Office of Saline Water to expand its program by requesting increased appropriations without curtailing its activities in fiscal 1963. In other words, any additional appropriation for expanded research in any one year (such as the additional $400,000 appropriated for research in fiscal 1960) is merely deducted from the total available authorization. (The existing legislation authorizes the expenditure of a total of $10 million during the fiscal years 1953–63, inclusive. The present budget request of $1,355,000 represents a pro rata share of the remaining authorization. Any appropriation above this amount only serves to reduce the money available for the remaining years of the program.)

The appropriations for the construction of demonstration plants will continue until 1965. It obviously will be necessary to revise the legislation in order to have these plants built under the continuing supervision of the Office of Saline Water.

Unless extended by law, the program will come to an end on June 30, 1963. Unless extended soon, its operations will become increasingly difficult and fruitless because they must be planned, and contracts let, a year or two or more ahead. Unless additional funds are authorized and appropriated there can be no expansion or acceleration of the program.

How does the Office of Saline Water appropriation compare with those for other Federal activities?

The administration's fiscal 1961 request for flood control, navigation, irrigation, power and related water resource projects for the United States is $1.2 billion.

The estimated 1960 budget expenditure for the Atomic Energy Commission is $2,289,114,000.

The estimated 1960 budget expenditure for the Department of Defense's rivers, harbors and flood control program is $815,320,000.

The Bureau of Land Management of the Department of the Interior which administers public lands for purposes of conserving forest range, mineral and water resources has an estimated 1960 budget of $85,665,000.

The Forest Service of the Department of Agriculture has an estimated 1960 budget of $104,150,000.

The geological survey program of the Department of the Interior which studies topography, geology and water resources has an estimated 1960 budget of $40,862,000.

The estimated 1960 budget expenditure for the Office of Saline Water, which administers a program for the constructive development of new and additional water resources for a vast potential of industrial and agricultural use, is $3,605,000 ($1,755,000 for research and development, plus $1,850,000 for construction).

The budget request of the Office of Saline Water for fiscal 1961 is less than one-half of 1 percent of the Department of the Interior budget request.

Has the saline water conversion program made satisfactory progress?

The report by the House Committee on Government Operations, published August 12, 1958, states: "While a good deal of progress has been made in the saline water program since 1952, within the framework prescribed by the limitations of the Saline Water Act, the Department of the Interior has been contented with the gradual progress and has not regarded the program with the sense of urgency which Congress intended it should have. Illustrative of the Department's attitude is the fact that the Department has, in the past, deferred or cut back admittedly important projects on the ground that the fiscal and other limitations in the Saline Water Act would preclude such work, yet has not recommended modification of those limitations.

"The progress of the Office of Saline Water program is being hampered by unduly small allocation of funds for basic research, by deferring research and testing in pilot plants of many promising processes which are ready for such work, by lack of a Federal seashore laboratory for saline water research, and because contractors are frequently uncertain of getting the long-term financial support from Office of Saline Water needed for continuity of research-staff effort."

What are the chief technological problems that must be solved to develop a practical and economically feasible water conversion plant?

Low-cost saline water conversion is a problem which has not been satisfactorily solved to date. New ideas and new processes are needed and can be achieved only through fundamental research. It is very unlikely that the conversion processes presently available for the demonstration plants are the best that can be developed. Further research not only can improve those processes, but it also holds promise of developing entirely new methods which may permit the attainment of a major breakthrough.

Energy requirements, scale formation, and corrosion are among the major technological problems that still must be solved to provide low-cost fresh water from sea or brackish water.

What could low-cost desalinization mean?

To the Federal Government?—It would be a major victory for the forces of democracy if the United States should develop and be in position to export practical, low-cost means to alleviate water shortages in the several dozen of countries of the world which are arid or semiarid. The United States would thereby greatly enhance its international prestige, gain the gratitude of millions in the uncommitted and newly developing countries, and contribute immeasurably to a prosperous and expanding free world economy.

If conversion costs can be sufficiently reduced, hundreds of millions of people who live mostly in underdeveloped countries might be spared the hunger and famine which they periodically suffer and build more rapidly prospering economies.

To the States?—Arid and semiarid States would be able to reclaim lost areas for agriculture. Water-short States would be able to attract new industry, and sustain growing populations.

To the local community?—Hundreds of communities which now suffer acute, periodic, or sustained water shortages would be spared suffering and inconvenience. With an assured supply of water, local communities in doubtful water areas could expect to grow, and gain in taxes from new manufacturing and service industries.

To industry?—Industries would be able to expand in their present locations, secure in the possession of necessary water for a multitude of new processes; and they would be able to expand into, or establish themselves in, areas now completely closed to them because of the lack of adequate supplies of fresh water.

The development of low-cost conversion methods would inevitably result in the opening up of enormous markets, at home and abroad, for conversion equipment, both large scale—for municipalities, industries, and irrigation—and for individual homes.

To agriculture?—Large arid and semiarid areas of the United States, now almost floating on seas of unusable underground brackish waters, could be opened to agricultural use for a growing population if the cost of converted water could be brought down low enough.

Farmers now irrigating areas with uncertain water supplies could be spared the ruinous consequences of drought if they had an alternative supply of sufficiently low-cost converted water.

DEPARTMENT OF THE INTERIOR INFORMATION SERVICE

OFFICE OF THE SECRETARY

[For release June 3, 1960]

SAN DIEGO TO BE SITE FOR NONNUCLEAR WEST COAST SALINE WATER CONVERSION DEMONSTRATION PLANT

The west coast saline water conversion demonstration plant will be erected on Point Loma at San Diego, Calif., with a conventional heat source instead of a nuclear reactor as previously planned, Secretary of the Interior Fred A. Seaton announced today.

Under a cooperative agreement with the Atomic Energy Commission the Department and the AEC had planned a joint project: the Department to construct and operate a 1-million-gallon-per-day multistage flash distillation plant and the Commission to construct and operate a 40,000-thermal-kilowatt experimental low-temperature process heat reactor to provide steam for the conversion plant.

The Safeguards Committee of the AEC has ruled against the site as a location for the reactor. Other proposed sites have been investigated as a location for the joint project, but none of the alternate sites met the Department's site criteria as well as Point Loma.

In addition to the ideal technical factors and demonstration value of the Point Loma site, the city of San Diego has offered full cooperation and will assist in the development of the site by grading the site, providing an access road and parking lot, and constructing a connecting pipeline to the city's water system. In addition, the city will also purchase the product water of the plant.

The State of California has appropriated $1.5 million for saline water conversion and will participate in the construction of this plant by providing up to 50 percent of the construction costs.

To prevent further delay of the plant, the Department has advised the Fluor Corp., of Whittier, Calif., who have the contract for the architect and engineering of the plant, to proceed as rapidly as possible with the design and specifications of a plant for the Point Loma site utilizing a conventional heat source.

Senator ANDERSON. As I envision it, an effective saline water program must have two fundamental streams of activity: basic research and process demonstration.

The basic research program could be as extensive or as limited as policy and appropriations dictate, but the demonstration program should be limited to the production-scale testing of promising existing processes.

In any event, the objective should be the development of methods or devices for the production of low-cost potable water for domestic, industrial, and related purposes.

A letter dated June 6, 1960, from the Bureau of the Budget relating to S. 2816, a bill to authorize loans for the design and construction of sea and brackish water conversion plants, and for other purposes appears in the record following the bill. This position of the Bureau of the Budget suggests that title II of S. 3557 may be open to question.

Since the hearing was set, we have received the departmental reports on two related bills, S. 2816 and S. 3446. Copies will be inserted in the record at the point where the bills themselves appear.

I want to say to the sponsors of this legislation that they are all before us and will be considered as part of the general program when we get to the final attempt to come out with some sort of a bill.

The distinguished majority leader, Senator Lyndon B. Johnson, the senior Senator from Texas, who is the chief sponsor of S. 3557, is recognized for the purpose of inserting in the record his remarks on this important bill, together with the remarks he made on the floor of the Senate when the measure was introduced.

STATEMENT OF HON. LYNDON B. JOHNSON, A U.S. SENATOR FROM THE STATE OF TEXAS

Senator JOHNSON. Mr. Chairman, it is a real pleasure to appear before your subcommittee this morning to testify on S. 3557, the saline water conversion bill, which I have the honor of coauthoring with you and 19 of our colleagues. I am sure that everyone here is well aware of the leadership that you, Mr. Chairman, have exercised in this field since the first substantial steps toward initiating some real research, development, and demonstration work in this field began.

Under the programs that have been initiated largely because of your efforts, considerable progress has been made in reducing the cost of

converting to human use brackish and ocean waters which were of abundance.

Two years ago I had the privilege of joining with the chairman of this subcommittee in urging the Senate to approve the construction of five pilot plants. Three of these plants are now under construction and the other two are in the design stage.

The purposes of S. 3557 were explained in considerable detail in the statement that I made on the floor of the Senate upon introducing the bill. That statement also contains the dimensions of the kind of program that I believe should be funded during the first year of operation under the bill. I ask the consent of the committee to incorporate into the record of this hearing a copy of that statement.

I am sure I need not dwell at any length upon the advantage and, indeed, necessity of expanding and enlarging our efforts in the field of saline water conversion. Those of you here understand both the need, which grows more intense with each passing year, and the potential benefits that will be ours when commercially feasible conversion programs have become a reality.

This bill would essentially use Senate Joint Resolution 135 as a foundation for an enlarged research, development, and demonstration program, and it would add one new major feature. Title II of the bill authorizes loans to municipalities and other public agencies for the purpose of building saline conversion plants on a local basis. The bill also authorizes within specified limits the use of foreign research in the program.

Again, may I express my appreciation for this opportunity to appear before you. I most strongly urge favorable consideration of the legislation and the early reporting of it to the Senate.

(The statement referred to is as follows:)

TEXT OF STATEMENT ON FLOOR OF SENATE

By 1975, America will face a severe and possibly disastrous shortage of water—unless we take steps now to avoid it.

This is a cruel fact, Mr. President, and it concerns not only arid sections of our country where water shortages occur daily, but also the traditionally water-rich regions where spot shortages are appearing. Our water problem is not regional. It is nationwide.

We have the resources to meet this problem, in the sea water around us and in the underground reservoirs of brackish water beneath us, but our present efforts to convert these vast reservoirs of saline water into usable form are inadequate to meet the national demand for water in the decades ahead. These efforts, though they have made progress, are small compared to the technical difficulties standing in the way of economical saline conversion. These difficulties give no promise of any dramatic breakthroughs. Rather, they require sustained research and development on a great number of engineering questions so that, as we find answers, we may gradually reduce the cost of conversion.

We are in a race against time. For the sake of our homes, our cities and towns, our industry and agriculture, we cannot afford to delay.

I am therefore introducing a bill to provide for an accelerated program of research and development to find economical means of converting saline water. The bill will remove present restrictions of time and money on saline development and will offer loans to communities wishing to build developmental conversion plants. I believe it will put us in a position to meet our coming water crisis.

The problem of supply—today and tomorrow

The dimensions of this crisis, as they can be seen today and reasonably estimated for the future, may come as a surprise. Here are some statistics which indicate the gravity of the situation for our entire Nation:

The U.S. Geological Survey reports that the total national supply of readily available water is about 515 billion gallons daily. With our current population of about 180 million, our daily water requirements are about 312 billion gallons, or about 60 percent of the available supply. And already severe shotages face parts of the Nation.

By 1975, however, our population will reach 235 million and our daily water requirements will be 453 billion gallons. Since there is no reason to expect that we will have expanded our natural supply of water much above the present 515 billion gallons, we will then be using nearly 90 percent of our available supply. Since we have shortages today when we use only 60 percent of the supply, it is not difficult to imagine the severity of the shortages which will confront us when we consume 90 percent.

As an indication of how water use grows, U.S. daily water consumption in 1900 was an estimated 40 billion gallons. By 1940, it had grown to 135 billion gallons; today it is 312 billion.

Population growth is only one reason for the steep increase in our water consumption. Our rapid industrial growth and the increasingly complex production techniques that accompany it call for progressively more water. Today, industry uses 40 percent of all the water we consume and this proportion is growing rapidly.

Consider this: it takes 60,000 gallons of water to make a ton of steel; 240,000 gallons to make a ton of newsprint or a ton of acetate and 660,000 gallons to make a ton of synthetic rubber. All major industries are heavy users of water; they expand only where local water supplies can support expansion.

Mr. President, we need not look into the future for signs of water shortage; the distress flags are flying in many communities across the Nation today. According to Geological Survey, there are 1,000 communities in 47 States which were forced by shortages to restrict water use in 1957. In my own State of Texas that year, residents of Dallas lined up to buy water at 50 cents a gallon—double the price of gasoline.

In some gulf and Atlantic coast States, overtaxed underground reservoirs and streams have been depleted to the extent that contaminating salt water is seeping in with harsh consequences for the communities involved.

As a result of actual or prospective situations of this sort, many communities have put in requests for experimental saline conversion plants provided under Public Law 85-883. More than 200 communities offered building sites to the Office of Saline Water—although this act provided only $10 million to build plants—and this number included many in the East. Official interest was shown by New York, Rhode Island, New Jersey, North and South Carolina, Florida—indeed by every State on the coastal perimeter of the United States.

Complicating the problem of local water supplies is the fact that many municipal waterplants were built 24, 40 or even more years ago. They tapped the most readily available and cheapest water sources, and now these communities are finding that it is too expensive to go farther afield to get new fresh water supplies. Californians will soon be asked to approve a $1.75 billion bond issue so that water for southern California can be brought from the north 400 miles away—across a 4,000-foot mountain range.

A special master of the U.S. Supreme Court just handed down a decision concerning the diversion of water from the lower Colorado River. Arizona, California, Nevada, and New Mexico were all eager to use this water. A "shrinking supply" coupled with increasing demand for water led to the competition between the States for its use, according to the Court's master.

It is plain that the water crisis is already widespread and severe in some areas. It is also plain that this crisis can only get worse unless we act.

The availability of saline water

We can, of course, conserve water in many ways and I urge that we do it. We can save water with new dams and reservoirs, by improving pollution control, by better industrial reuse of water and sewage disposal. We can do all these things but they can only make our available natural water supply go a little further; they cannot increase that supply.

To do this, we must turn to our inexhaustible sources of saline water. We are well situated to do so: 55 percent of our population and 65 percent of our industry are in States bordering the ocean. Some of our States literally float on submerged salt water seas; others have extensive underground deposits of brackish water. The water is there; it is up to us to find ways to tap it in time.

56852—60——3

Congressional background

The problems of which I have spoken, Mr. President, are not new to the Congress. The Senate just last year appointed a select committee, under the chairmanship of the distinguished Senator from Oklahoma, Mr. Kerr, to make a complete study of the Nation's water resources and find ways to conserve and develop them. This committee has been hard at work, and I am told we will have its report next year.

The history of congressional interest in saline conversion goes back at least to 1952, when the Congress, at the request of President Truman, authorized a 10-year research program to search for economical conversion methods. This led to the creation of the Office of Saline Water in the Department of Interior—but with an average annual budget of less than $1 million.

Again, in 1958, Congress authorized the construction of at least five saline conversion plants over a 7-year period, but with a total program cost of no more than $10 million. Construction is due to start soon on three plants, and design is underway on two more.

It is obvious that these two temporary programs, for all they have accomplished, are to small and hamstrung by legislative restrictions to meet the growing water crisis our Nation faces. And it is senseless that these programs should be temporary, due to end before they have found concrete solutions to the problems that face us.

Considering the nature of these programs, the Office of Saline Water, I think, has done an admirable job with the facilities and funds at its disposal.

The Office operates through research grants to public and private institutions, as well as other agencies of the Federal Government. But it has never had its own laboratory or test facilities, and its small technical staff is confined to directing and coordinating the activities it contracts for.

Furthermore, its research work has been restricted as more conversion pilot plants have gone into operation—the Office of Saline Water now has 11 of these working—and research work will likely be cut back further as more funds are needed to run pilot plants. In fiscal 1960, the Office is operating on a budget of $1,755,000, plus $1,850,000, for plant construction. For fiscal 1961, the administration has asked for $1,355,000, plus $2,040,000 for demonstration plant construction.

These amounts are most inadequate for the Office of Saline Water to do the job it must do—and which we so desperately need to have done.

Progress so far; difficulties ahead

In the nearly 8 years since we established a research program to find cheap ways to convert saline water, we have turned up much promise of succeeding. But it is clear that we must broaden and strengthen our efforts.

Already, the cost of converting saline water has come down sharply. Ten years ago, the cheapest we could make usable water from sea water was about $4 a thousand gallons. Now, some plants can do the job for $1.75 a thousand, and a plant under construction in Freeport, Tex., is expected to cut this even more to $1 a thousand.

But this is not enough when you consider that most municipal water in the United States costs in the neighborhood of 30 cents per thousand gallons.

There is every reason to believe intelligent research will bring costs down to an economical point. Indeed, already it is cheaper for some communities to convert water.

Coalinga, Calif., for example, was hauling in water at a cost of $9.35 per thousand gallons. Now, residents are drinking fresh converted water which costs $1.45 per thousand.

But scientists and technicians tell me there is still no assurance that they have even hit on the proper way to convert salt water economically.

Research currently centers around five main areas. They are:

1. Distillation—an age-old process brought up to date. Great cost-cutting progress has been made in the conservation of heat and scale and corrosion control.
2. Solar distillation—using heat from the sun.
3. Membrane conversion—using a combination of thin membranes and electric currents to screen out dissolved salts.
4. Freezing—an experimental method. Frozen water crystals separate themselves from salt crystals, and researchers are trying to find ways to remove the salt from the ice.

5. Other chemical and electrical methods—using gas hydrates, controlled absorption, and other experimental means.

Researchers feel there is little chance of a revolutionary advance in saline water conversion. Instead, they believe that only continuous and more intensive research can bring the answer to a host of engineering questions. These questions are minor in themselves but, if solved, they can produce gradual cost reductions with the cumulative effect of a major breakthrough.

I believe we have reached a crucial point in the development of saline conversion. We must remove the present restricted limits of time and finances from the program and establish it as a continuing project subject to annual appropriations. We must begin also to translate research programs into operating plants. I have included this provision under title II of the bill, which authorizes loans to communities and other public bodies to build saline conversion plants and to have one-quarter of their loans cancelled if the Office of Saline Water uses these facilities for research and demonstration of conversion processes.

Title II of the bill is similar to bills which have been introduced in the House by Congressmen Aspinall, Rhodes, Saylor, Wainwright, Udall, and Wilson; and into the Senate by Senator Allott on behalf of himself and Senators Case South Dakota, Chavez, Kuchel, Engle, Goldwater, Fong, and Long of Hawaii.

On the basis of research available to me, I would like to outline here my conception of what an adequate program for fiscal 1961 might comprise:

1. Research.—Funds available to the Office of Saline Water for research contracts averaged only $36,000 a year from 1953 to 1958. This is insufficient. Research should be stepped up on small conversion units, on extraction and use of byproducts, on the nature of heat exchangers and compressors, the use of atomic energy, and many other technical problems. Unallocated funds should also be available to take advantage of new ideas that come along from sources outside the Government. We should have $2 million available for this whole area of general and fundamental research in fiscal 1961.

2. Process development.—Processes resulting from research must be tested in large-scale pilot plants to be demonstrated on a practical scale. Pilot plants are expensive, but the OSW had an average of only $200,000 a year available for their construction from 1953 to 1958. A reasonable figure for process development in fiscal 1961 would be $2.6 million.

3. Demonstration plants.—The test methods proven to have potential in pilot plants need to be tested full scale. Often "bugs" are discovered in full-scale plants which did not show up in pilot plants, and they serve as practical training grounds for operating converters.

Most technicians and scientists agree that the five plants being built under the 1958 law will be only a start, since varying conditions in different sections of the country require different processes. The use of gas hydrates in conversion, for example, is rapidly nearing the stage of development where it will be ready for demonstration. Of the five plants in the works, none use this process.

The entire demonstration program could be speeded greatly by appropriating for fiscal 1961 the rest of the original authorization of $10 million, or $8,150,000.

4. A test site and laboratory.—The entire program of saline conversion research has been hampered by the lack of a central test site and laboratory. The Office of Saline Water does not even have a central staff. Right now, OSW research is carried on at widely dispersed places under unsatisfactory conditions. What's more, the entire OSW staff numbers just 25, only 10 of whom are scientists and engineers who direct and coordinate research by the Government and private contractors.

A central laboratory, located near both sea and brackish water, would give the program a good boost. It would not reduce the number of contracts for outside research, but rather would likely increase private work because of more research ideas which would come up.

5. Coordination of research at home and abroad.—There is a great deal of scientific interest in saline conversion in other nations, as well as the United States. OSW would profit if it could keep up with this work by having available both domestic and foreign scientific literature and issuing its own periodical information, by inspecting conversion sites at home and abroad, by taking part in conferences relating to saline conversion, and by correlating all this information for easy use.

About $500,000 a year would provide for this.

6. Economic studies.—One of the greatest unknowns about saline conversion is its cost. Without accurate cost studies, communities cannot intelligently decide whether they should install saline conversion facilities, and as current water supplies diminish, this will become increasingly important.

Continuous economic studies and water market surveys could be made for about $500,000 a year.

The second part of the bill contains the important provision for aiding construction of conversion plants. Right now, commercial conversion of saline water would probably be cheaper for many communities than obtaining water from natural sources. But these communities understandably hesitate to put money into plants which may, in later years, turn out to be high-cost operations.

Federal assistance, in the form of loans, is necessary to bridge for a few years the gap between experimental plant operation and practical application of conversion plants. Such a program would also help get new plants built and operating, and would add to the stock of technical and cost information and speed the entire program.

The appropriations suggested here would amount to about $17.5 million for fiscal 1961. Part of this would be nonrecurring—the amounts for construction and plant site acquisitions, for example. Loans under title II would be automatically appropriated as the loans are made.

This expenditure is one of the best our country could make in its future. There is no question that it would hasten the day when we can assure adequate water supplies, not only to our own cities and towns, but also to other parched communities throughout the world through the dissemination of what we learn. We are in a good position to meet a coming crisis right now.

Senator ANDERSON. Our usual practice is to try to take the Members of the Senate who have other assignments as early as possible. Therefore, I will call on a pioneer in this field, Senator Case of South Dakota, who has been very much interested in all of this work and in many other fields related to water supplies.

Senator Case, we are very happy to welcome you. We have appreciated for a long time your very fine and very constructive thinking in the field.

STATEMENT OF HON. FRANCIS CASE, A U.S. SENATOR FROM THE STATE OF SOUTH DAKOTA

Senator CASE. Thank you very much, Mr. Chairman.

I think, if you toss bouquets around, the chairman of the subcommittee is the one who deserves credit for the striking position which the saline water program finds itself in today. It was really his sponsorship of a bill to provide demonstration plants that has really aroused the interest of the whole country.

Senator ANDERSON. I did not get it done by myself. The Senator from South Dakota knows how much he helped.

Senator CASE. I was privileged to join with you in those hearings and in the sponsorship of the bill.

Mr. Chairman, I have prepared a statement in which I do recite a little of the history, legislatively, simply for the purpose of continuity. Then I will want to say something on the bills which you have mentioned.

This committee is taking a great forward step in meeting our present and future needs for water in the consideration of this bill to expand and extend the saline water conversion program.

The legislative history of saline water conversion is relatively brief. Following the interest shown by former Secretary Chapman, as the chairman mentioned, it was only in 1952 that the Congress first began to meet its responsibilities in this field by passing a simple bill that

drew little attention at the time—that bill authorized the Department of Interior to make contracts with research foundations and industry and authorized the expenditure of only $500,000 a year over a 5-year period.

That act grew out of bills introduced in the House of Representatives by the then Representative Clair Engle, of California—now Senator Engle—and Representative John Phillips, of California. Senator O'Mahoney of Wyoming introduced a companion bill in the Senate, and it was my privilege to sponsor the amendment in the Senate which became the final language of the act known as Public Law 448 of the 82d Congress.

In 1955 Representative Engle and Representative Frank T. Bow, of Ohio, for the House of Representatives, and I for the Senate, introduced legislation to expand the research and development program in this field. The legislation then passed authorized expenditures of a total of $10 million over a 10-year period and modified the basic act by permitting research to be carried on to a limited extent in existing Government laboratories as well as by contract with research foundations and industry.

I recall, Mr. Chairman, that you played an important part in securing approval for the increased authorization at that time. In fact, Mr. Chairman, I think that was the time when you silenced one of the Members of the Senate who was disposed to ridicule the idea by pointing out that if this program were solved, it might help to end the Arizona water controversy, pointing out that even some of the lawyer lobbyists for that legislation might be out of a job if we managed to make it possible for the sea water washing the shores of California to supply the needs of California so they did not have to fight with Arizona for water.

Senator ANDERSON. I will say to the Senator from South Dakota that the special master for the Supreme Court has spoken and leaves California completely unsatisfied. It restricts California a little bit to what it once put on as a self-limitation.

Noting the tremendous growth in California, particularly in southern California, we can see how much more easily they could have taken that decision by the special master if they knew that operating just outside of Los Angeles was a saline water plant to supply the future needs and remove the ceiling on population from that great city.

I think the things we said then are strongly supported by the special master in that California water case. Nobody is going to be happy. Even Arizona will be worried soon about what may come down to them from the States of the upper division.

I think the whole matter could have been reduced in its importance at least if we had had a program going full tilt for a longer period of years. I am very pleased that the Senator from South Dakota remembers part of that debate.

Senator CASE. I remember that was a very effective point that you made, and helped secure passage of the legislation at that time.

Then, Mr. Chairman, in 1958 you introduced the resolution which called for the construction of a full-scale demonstration plant for treatment of sea or saline water. That same year I introduced a bill providing for construction of two pilot plants for treatment of sea and brackish water—one plant to be located near the ocean to treat sea water, and one to be in the Great Plains to treat brackish water.

As hearings were held on these bills, it became apparent that the program should be expanded even more than that and the act of 1958—Public Law 85–883—called for construction of five demonstration plants—three for the conversion of sea water and two for the conversion of brackish water. Senators Kuchel and Wiley joined us as cosponsors of the bill as it came from committee.

The chairman has already referred to the most recent announcement of the Department in the establishment of those plants. The program is now underway, and at this point, Mr. Chairman, I think it is appropriate to mention the very helpful interest taken by Secretary Fred Seaton of the Department of the Interior and Dr. A. L. Miller, a former Member of Congress who has been heading up this Saline Water Division.

Senator ANDERSON. I would like to underscore what the Senator has just said, and to say also that I have been very pleased by the wonderfully fine attitude that Secretary Seaton has taken and by the energy that Dr. Miller, our former colleague from the House, has put into this program these last few months.

I am very pleased with it, and I know that the country is going to be benefited by it. The Secretary of the Interior has demonstrated that he is just as much interested in the program as you and I have been, probably because he lives only a short distance from where you and I used to live. We are very glad he has been so interested in it.

Senator CASE. We are now considering these bills to enlarge and broaden still further the purposes of the original act in order to better serve the needs of our times, and I hope the Congress will enact this forward-looking legislation.

There is great need for continuing to broaden the program, for water is our No. 1 problem in the Nation. The United States is using some 270 billion gallons of water a day. As early as 1957, some 1,000 cities—about one-seventh of the Nation's entire population—had imposed on them water restrictions of one kind or another.

Demands will increase so that by 1980 we will be using almost 600 billion gallons a day. The problem will be how to supply a growing population and a dynamic economy with increasing amounts of good quality water at a reasonable cost.

There are many Federal and State programs authorized that have as their objective the conservation and development of our available water supplies. These programs include such measures as dams and reservoirs, conservation practices, pollution control, evaporation suppression, industrial reuse, and weather modification.

All of these programs have made a valuable contribution to the development and utilization of our available water supplies. But even if every concerted effort is made to conserve and fully utilize the available fresh water supplies, there will not be enough to take care of future needs. There is only one other source to turn to and that is saline water, both brackish and sea water.

Three-fifths of the earth's surface is covered by oceans that contain an estimated 320 million cubic miles of water and, in addition, there is a potential supply of billions of gallons of surface and underground brackish water.

It is to the problem of converting that vast potential supply of water—now unfit for human consumption—to pure, usable water at

an economical cost, that holds our attention. To make this possible, an intensive research program should be undertaken. Such a program of research is outlined in title I of the bill of Senator Johnson and others, before you.

Basic research should be expanded and accelerated. New ideas and new processes are needed, and can be achieved only through basic research. We must seek to improve present methods and find new processes. We must begin with basic research.

While each of the five demonstration plants we provided for in 1958 is trying out a different process, additional conversion methods should be studied and developed and tried in order to hasten the day for fast and economical conversion of saline water. Such an expanded program is possible under the bill before you.

We should bear in mind, and keep in mind, that along with research there must be demonstration, Authority must be granted the Office of Saline Water to continue to build plants of good size in order to test out the various findings of the research in field practice. That calls for a broad policy, and much leeway in administration. This bill makes that possible.

The study of the commercial utilization of the byproducts of conversion should be the second priority in the research program. It is possible that the sale of the byproducts will very largely overcome the costs of water production.

In the long run, the uses for the various chemical elements in the byproduct may be of equal importance to the pure water itself. This field of byproduct utilization has not been fully explored, and I hope this bill will open the way for an intensive research study of this important problem.

Mr. Chairman, I would like to say that the success of the Dow Chemical Co. in recovering magnesium from sea water suggests the possibilities in this field. I am not optimistic enough at this time to think that there will be commercial benefits from recovery of minerals from sea water just for themselves, but as a byproduct of a water desalinization program that would recover water, these byproducts might well make a valuable result.

At the present time, under the 1958 act, there are either constructed, or in the process of construction, five pilot demonstration plants, each one demonstrating a different process: at Loma, Calif., the multistage-flash process; at Webster, S. Dak., the electrodialysis process; at Freeport, Tex., the long-tube method process; and at Roswell, N. Mex., the forced-circulation process.

These are but a few of the known processes and this bill should encourage the installation of additional pilot demonstration plants. It may do this on its own, under its terms, or in cooperation with municipalities. The several hundred applications for plants indicates the interest in the program.

It suggests further work in such processes as distillation, freezing, membrane and ion exchange, and many more. In the course of the studies, new processes may be discovered that are not in our present-day thinking.

Many countries of the world are working in this field. There is along the Persian Gulf a sea-water evaporating plant of 1 million gallons a day capacity, and plans are underway to expand it to 2½

million gallons. Algeria, Australia, Spain, Italy, Russia—all are working on the problem of converting sea water to fresh water.

Mr. Chairman, I was in Jerusalem in December, at the time an announcement was made of a contract under negotiation between the Government of Israel and Fairbanks-Whitney, for a freezing process. I have heard varying reports about it, but the interest that was taken in that announcement was tremendous in that part of the world.

It happened that during the same week I went over to Jordan and down to the city of Jericho, which is 1,800 feet below sea level, if I remember correctly. A fantastic idea occurred to me at that time and I mentioned it merely perhaps partly to show how your fantasies can run on this.

But it did occur to me that in that very arid country which is inadequately watered by the River Jordan and over whose waters there is considerable dispute, that some international problems even might be solved if it were explored and found feasible to take some sea water and bring it in where Jordan does have access to sea water, and taking the salt out of it, to get fresh water, and dropping it down over that 1,800 feet of fall to that much below sea level, and develop considerable hydroelectric power in the process of bringing fresh water into the very heart of Jordan.

What you would do with the water if you got it down that low—well, you might have to figure out how not to get too much into the Dead Sea. But imagination can see two or three things there: The possible hydroelectric power by taking the fall from sea level down to 1,800 feet below sea level, and converting salt water into fresh water and freshening the Dead Sea.

Senator ANDERSON. I am sure the Senator from South Dakota has seen a news story in the last few months outlining just some such project as that, with a route that the canal would follow indicated on a map.

Senator CASE. I must say that I had not seen that, but I threw the idea at some of the Jordanian people at that time.

Senator ANDERSON. Apparently it caught.

Senator CASE. They said that might be, but they just wished they could get the part of the Jordan River they wanted. But I didn't know there was very much interest. In any event, I think it might be worth exploring when we explore fantasies.

But this is not a fantasy, this desalinization of water. Our colleges have been making a great research contribution in this field. The use of their trained manpower should not be overlooked. They are breaking through some of the technological barriers, and any legislation at this stage of the development should encourage and financially support their effort.

The Department of Defense—Army, Navy and Air Force—are interested in this field and their assistance should be solicited. All of this is made possible by the text of the bill now before you.

I endorse all the features of this bill. Such provisions as an assembling center for scientific literature, both domestic and foreign, for economic studies, for cooperation with other agencies, for making grants for research to colleges and to communities for testing various processes by means of pilot plants, all will hasten the day when it will be possible to convert brackish and sea water to fresh, potable

water at a reasonable cost and in large supplies for both human consumption and industrial use.

This achievement will make a great contribution to the present-day problems of where the supply of fresh water is coming from to meet the needs of a growing population and an expanding industrial production.

Senator ANDERSON. Thank you, Senator Case.

Senator CASE. Thank you.

Senator ANDERSON. Won't you stay up here with us so that if you have questions of other witnesses you may feel perfectly free to ask them?

Senator CASE. I would like to stay for a while, but we are making up the Defense appropriations, so I will have to leave shortly.

Senator ANDERSON. Thank you.

(The following article from the New York Times was subsequently submitted and ordered printed at this point in the record:)

[From the New York Times, Thursday, June 9, 1960]

TOPICS

FRESH WATER FROM SEA WATER

The news that two companies jointly have developed a new process for producing fresh water out of sea water gives us the latest hope of fulfilling one of mankind's oldest dreams. For ever since man first became conscious, he has been a slave to water, and water too often has proved to be a perverse master, giving us too much water when we don't need it, too little when we do. Early in history man learned of the water paradox of his earth: a planet surrounded by water, yet offering man barely enough of the kind needed to sustain his life. The cry of Coleridge's Ancient Mariner—"Water, water, everywhere, Nor any drop to drink"—echoes throughout the centuries. And man's growth can be written in terms of his efforts to come to terms with these waters of his earth.

MAN'S WATER PROBLEMS

As man has multiplied, he had found new sources of water and new ways to harness old sources, but never has he been able to develop a surplus. On the contrary, sometimes it seems as if his water problems with the passing years become increasingly acute. So low did the water level in our town's reservoirs dip only a few years ago, for example, that we had to cut down the number of baths and the number of shaves of our adult males. Homeowners have been directed on occasion to defer the watering of their lawns by municipal fathers casting anxious glances at the rainless heavens. An adequate supply of clean water has long been a key factor in determining the location of industry. No one has been made more aware of the preciousness of water than the farmers, who in good times have known the necessity to haul it by truck from the cities, and in bad times they have known the calamity of erosion and the unbridled fury of the floods. Possibly worst of all, we have felt the heartbreak of finding clear water made impure by the intrusion of salt water.

TRIAL AND ERROR

But man has never given up the battle, and throughout his struggle for water nothing has intrigued him more than the effort to tame the destructive saline waters of the sea and to extract good, clean water from them. As long ago as the 14th century, when the Arabs laid the foundations of chemistry, the process of distillation was tried. And while this process always works, given a vessel that will contain the liquid and some means of condensing the steam that is driven off, the energy consumed has always been tantalizingly excessive. Other processes have been developed. Chemical action was used in Navy survival kits during the war. The kits contained silver salts that would react when shaken in sea water to take the salt out of it, leaving the silver in a form that

would oxidize and then precipitate—again a process too costly to be useful commercially. More recently, with improved knowledge of the way solids in solution become ions of their components, it has become possible to create fresh water from salt by ionization, but it has not yet been commercially proved with sea water.

A NEW PROCESS

Ever since the ammonia refrigeration method of making artificial ice was patented in the 1840's, the possibility has arisen of freezing sea water and thus expelling all impurities, including the salts. Frozen sea water is a mixture of pure water crystals and tiny salt crystals, the salt crystals occluded on the surface of the ice crystals. Up to this point the practical defect has been that every method devised to get the salt crystals off the ice crystals served to melt the ice crystals. The claim of the new process, developed by engineers of Struthers Wells Co. and Scientific Design Co., is that they have succeeded in centrifuging the salt off the ice, leaving ice crystals after the separation. It is too soon, of course, to know if we have finally hit on the elixir that can give us fresh water from salt, to end our water shortage and create, in Adlain Stevenson's phrase, "a new patrimony for the human race," but the stakes are so high that it's certainly worth giving any new process a whirl.

Senator ANDERSON. Our next witness is Senator Harrison A. Williams, Jr., of New Jersey. We are glad to have you, Senator. You may proceed as you wish.

STATEMENT OF HON. HARRISON A. WILLIAMS, JR., A U.S. SENATOR FROM THE STATE OF NEW JERSEY

Senator WILLIAMS. Mr. Chairman, I appreciate the opportunity to present my statement to members of the subcommittee.

I believe that S. 3557, of which I am a cosponsor, is a bill which has important immediate and long-range goals of importance to the entire Nation, and particularly to New Jersey.

Before I begin my statement, I would like to note that Mr. Carroll M. Shanks, president of the Prudential Insurance Co., is scheduled to testify in favor of the bill today. The appearance of Mr. Shanks, an outstanding civic-minded citizen of our State, is another sign of the growing interest within New Jersey and elsewhere in the saline water program.

I believe, too, that his appearance here will help to hasten the spread of public understanding about the importance of the matters with which the bill deals. I would like to add my welcome to those Mr. Shanks will receive here today.

Mr. Chairman, New Jersey, with 125 miles of coastline from Sandy Hook to Cape May, also has a population which, according to the latest census figures, is now around 6 million. As our population and the demands on our water supply grow with each passing year, it becomes more and more apparent that we may have to tap the great supply of ocean or brackish water so near to our coasts.

Already we have undertaken great State and local efforts to keep up with immediate needs and those of the next few decades. We are now discussing ways of developing the Delaware basin in a comprehensive multipurpose program to end flooding, increase water supply, and to yield other benefits.

Great as these efforts are, however, we would be unwise and unseeing if we were to ignore the warnings and predictions we hear so regularly.

On May 26, Gov. Robert Meyner, of New Jersey, urged acceleration of the saline water conversion program when he testified at a Senate Water Resources Committee. He said:

> The Nation fails to look ahead to the future if it neglects to accelerate research in this highly important field.

On June 5 we received two statements about the growing water needs of the United States. The Commerce Department predicted that daily water requirements in the United States would rise by nearly 70 percent in the next 20 years. Senator Robert S. Kerr, chairman of the Select Committee on National Water Resources, said on the same day that 70 million Americans already are using water that had been used previously by someone else. He expressed particular concern about urban area needs.

New Jersey, often called the most urbanized State in the Union, has particular reason, I believe, to be concerned about the likelihood of steadily increasing water demands in its cities and suburbs.

Among the signs of concern that have already been expressed in New Jersey has been the response of the Office of Saline Water's program to select a saline water conversion demonstration plant somewhere on the Atlantic coast. The sites selection committee has already narrowed down the number of communities now under final consideration to 13 Atlantic seaboard communities. Atlantic City and Cape May are among those 13.

The municipality finally selected as the site would test a freezing process which would convert sea water to fresh at a rate of 100,000 to 500,000 gallons a day. The interest shown in this project is indicative of the interest in an even greater effort which would make the Federal saline water conversion program a dependable and adequate source of potentially inexhaustible supplies of water for citizens of the United States.

Senator ANDERSON. Thank you, Senator.

We have today, also, Senator Allott, as a member of this committee, who is the author of S. 2816 for himself and other Senators. This is a bill to authorize loans for the design and construction of the sea and brackish water conversion plants.

This comes as title 2 of this bill.

Senator Allott, I wonder if you have a statement you would like to present at this time.

Senator ALLOTT. I do not, Mr. Chairman, except that I would like to make a comment. I just had an opportunity to hear the fine statement of Senator Case on this matter. I have been interested in this, myself, a long time. It has already been pointed out that the bill which I offered earlier this year on April 29 is part 2 of S. 3557, and the first part, of course, of that bill refers primarily to research and development. I do support it.

Because of the numbers of witnesses here, I would prefer that we go on to them so that we can proceed with the hearing.

Senator ANDERSON. Thank you, Senator Allott. I merely wanted to call attention to your longtime interest in this problem.

I have also a wire from Paul G. Hoffman, reading:

NEW YORK, N.Y., *June 7, 1960.*

HON. CLINTON P. ANDERSON,
Chairman, Senate Committee on Interior and Insular Affairs,
Washington, D.C.:

Most grateful for your invitation to submit for inclusion in record a statement on important Senate bill 3557 concerning saline water program. Am mailing statement which I hope will not only reflect my personal enthusiasm for bill but also indicate its undoubted significance for some 60 underdeveloped countries and territories of the world whose progress hinges in an important way on their obtaining converted Saline water in considerable quantity at low cost.

PAUL G. HOFFMAN,
Managing Director, United Nations Special Fund.

(Mr. Hoffman subsequently submitted the following statement:)

STATEMENT OF MR. PAUL G. HOFFMAN, MANAGING DIRECTOR, UNITED NATIONS SPECIAL FUND

The growth in the absolute and per capita demand for fresh water is not alone a U.S. problem; it is also an international problem of terrifying proportions. Indeed, grave as forecasts are concerning the adequacy of present and future supplies of fresh water in the United States, compared to the quantity of water available on a per capita basis in most other countries of the world, the United States is one of the water-richer countries. At least 60 of the 100 underdeveloped countries and territories associated with the United Nations face forms of water shortage which in time can only be met from nontraditional sources—that is, from brackish and salt water sources.

I do not minimize the still extensive possibilities of adding underdeveloped ground water resources or unutilized surface water resources to fresh water supplies. In the United Nations Special Fund, we are devoting an important part of our resources to the development of additional water supplies and we are persently financing ground water surveys in a considerable number of countries. But in most of these countries, this represents the development of their last fresh water reserves.

It is obvious that in the not-too-distant future even a full and efficient use of all available fresh water resources will not cover the growing fresh water demand of the human race on this planet. Therefore, from a quantitative point of view the only large-scale sources of additional fresh water are the oceans and saline brackish water bodies.

For this reason, saline-water conversion projects of the United States are of great interest to the United Nations. It is no exaggeration to say that what the United States may accomplish in solving this problem, whose significance is growing in America, could have tremendous impact in other parts of the world—in Africa, the Middle East, Asia, and Latin America. In many countries in these areas the pace of economic development is strongly influenced, if not controlled, by the development of techniques to obtain large quantities of essential water at a reasonable cost. Some of the countries are already experiencing rationing and price control of water; and in certain of the arid and semiarid areas the key to political stability and progress is tied to their obtaining substantial amounts of drinking water, and water for livestock and agriculture required by their rapidly growing populations.

It is encouraging that progress in technology and reducing conversion costs already gives promise of substantial benefit to human welfare and economic advance. The cost of converting saline water, which was about $4 per 1,000 gallons before World War II, has already come down to about $1. Further, pilot plants now under construction in this country and Israel hold out the hope of reducing such water costs to between 40 and 50 cents per 1,000 gallons.

In this connection, I believe it is essential to bear in mind that demineralized water, if available for around 50 cents per 1,000 gallons, would be acceptable in price in many countries for domestic water supply, as drinking water for animals, and to meet the almost insatiable demands for water for thermal-power production and industrial growth. Water of even lower cost is needed practically only for agricultural irrigation. On some of the Spanish islands

in the Mediterranean, as well as in Guernsey, distilled water is already being used for highly valuable flower and vegetable crops. But it will doubtless be some time before we see the important day when saline water can be converted at rates cheap enough for the large-scale irrigation development which is needed in many of the low-income countries of the world.

If progress is encouraging, that is all the more reason to accelerate its pace. The main difficulties today standing in the way of a rapid expansion of saline-water conversion are the need for further research and greater knowledge of existing technical possibilities, the lack of investment capital, and, not of least importance, the lack of initiative because this is a development which is not being financed by private enterprise.

These are among the problems the bill before you seeks to face. Because they are universal problems, the United Nations ardently hopes for their progressive solution; we would like to see the results of discoveries in one place applied for the benefit of people elsewhere. Out of the program now under consideration should come some exciting developments and many advantages for the world community.

It could result in removing impediments to progress created by water shortages, and make feasible many new agricultural, industrial, and community projects. It would therefore permit a significant development in the United Nations Special Fund's preinvestment work to speed economic advance in the low-income countries. I am confident it will lead to possibilities for very fruitful investment in many countries.

The appropriation suggested in bill S. 3557 appears to me personally to be very reasonable in relation to the size of the task and the contribution it would make toward meeting a problem of present and ever-growing urgency. The amount proposed is almost infinitesimal in comparison with what is being spent by our country on atomic energy sources at home and abroad; yet water, the only commodity for which there is no substitute, is the vital fuel for life and progress.

In sum: It is high time that much more be done about increasing the supply of lifegiving water—in the United States and in the world. I believe that bill S. 3557 marks an important step in that direction.

Senator ANDERSON. Are there other Members of the House or Senate who have statements that they would like to present for the record?

Senator Moss?

Senator MOSS. I had not prepared any particular statement, Mr. Chairman.

Senator ANDERSON. If you desire to submit one at this point later on, it may be done.

The first of the outside witnesses will be Mr. Carrol Shanks, president of the Prudential Insurance Co. of Newark, N.J.

Mr. Shanks, we know a great deal about your interest in civic matters and business affairs and we are happy to welcome you as a witness.

Mr. SHANKS. Thank you, Senator.

Senator ANDERSON. Mr. Fred Smith, of Prudential, is here also. We served on the Outdoor Recreation Resources Review Commission and many other things together.

Fred, it is good to see you again.

Mr. SMITH. Thank you, Mr. Chairman.

STATEMENT OF CARROL SHANKS, PRESIDENT, PRUDENTIAL INSURANCE CO. OF AMERICA; ACCOMPANIED BY FRED SMITH, VICE PRESIDENT

Mr. SHANKS. Mr. Chairman, Senator Allott, and Senator Moss, my name is Carrol Shanks. I am president of the Prudential Insurance Co. of America.

For the record, I will say I am accompanied by Mr. Fred Smith, a vice president of Prudential, who has done considerable study in this field.

In 1958, as chairman of a citizens' committee in New Jersey, I helped to secure the passage of a referendum to make possible a partial solution to our own mounting water supply problem.

Water problems are common to the highly populated East, and to all highly populated areas across the country, so what I have to say applies to many areas. It is important to note that we and many other sections of the country have water shortages in spite of a very high average rainfall.

As we said in our 1958 campaign, in New Jersey the rain goes mainly down the drain, and this seems to be the general situation because the problems of storage are difficult and expensive to solve.

I should like to make four points in support of S. 3557: First, this bill recognizes that in metropolitan areas, where population is exploding, where water uses are multiplying, and where increasing demand for land or other uses greatly curtails the availability of reservoir sites, the conversion of sea water or brackish water may provide our only chance for water security.

What is happening in New Jersey is typical of the situation in other Eastern States. In 1957, water trucks had to trail fire engines in some communities because water pressure had dropped so low that hydrants were unusable. Most New Jersey towns enforced "no sprinkling" regulations.

Drinking water was so scarce that restaurants were permitted to serve water only on request. In Orange, an ordnance was passed providing a $200 fine for leaky faucets. Firemen hauled water to New Jersey farms, but they could not stop tremendous drought losses.

For the first time within memory, people turned on their water faucets and nothing came out. The department of conservation was unable to find any solution, and one member of the department told me later that we were only a few days from absolute catastrophe in the State.

We had lived with a critical water shortage in New Jersey for 10 years, and for nearly 30 years efforts of various sorts were made to remedy the situation that obviously was threatening. By 1956 we found that even with adequate rainfall—and New Jersey's rainfall is well above average—water supply barely equaled water consumption. That was 1956.

Lack of rain, even for a short time, would cause a crisis. We were headed for a water deficit, by 1960, of 67 million gallons per day. By 1975, we would be at least 267 million gallons per day short. By 2000, our deficit would be almost a half-billion gallons a day, and none of these projections anticipated the growth of the State at the rate just revealed—an increase of nearly 25 percent in 10 years.

Even with these projections, we made no headway in solving the problem. The reason was relatively simple and applies equally to other highly populated eastern areas: Solving the problem would require surface water storage, and this meant a tremendous expense and the acquisition of substantial blocks of real estate in strategic locations.

New Jersey has overwhelming and growing land demands, and real estate values are so high that some of our farmlands are more valuable

than many urban area building sites in other sections of the country. The acquisition of sites for reservoirs which would be both practical and available proved almost an impossibility—one public referendum failed to pass because of public opposition to acquiring the site.

In 1958, faced with obvious crisis, and helped by a highly organized drive by most of the civic leaders of the State, a referendum was finally passed and the immediate crisis relieved.

Senator ALLOTT. May I interrupt you there, Mr. Shanks?

Going back to your previous sentence, you say one public referendum failed to pass. The acquisition of reservoir sites became almost an impossibility.

Was this because of the cost factor?

Mr. SHANKS. It was not only the cost factor, but also the antagonism and resistance by the people residing in the area.

Senator ALLOTT. To the sites?

Mr. SHANKS. Yes. I can say the resistance was the fact more than the cost.

Senator ALLOTT. Thank you.

Mr. SHANKS. Two reservoirs with a total capacity of approximately 66 billion gallons were finally authorized, but this is really only a stopgap. In some areas, we will be right back in the same critical water situation within the foreseeable future. I mean by that certainly within the next decade. Our conservation department has already announced that another reservoir will have to be built—if we can find a place to build it—in a few years.

It is my opinion that we will have no choice but to go to salt water conversion if conversion, by that time, is ready for actual use on anything like a large scale. If it is not, I do not know what we will do.

Senator ANDERSON. Doesn't this constant development of reservoir sites run contrary to the constant development of additional population?

Mr. SHANKS. It is a headon conflict, and if the population gets there first, which it has in most areas in northern New Jersey, at least, then you have the problem of destroying these homes and whatnot, and the political problem of passing a referendum is just tremendous.

Senator ANDERSON. So that really the conversion of sea water is the great hope that you have.

Mr. SHANK. Yes, sir. It is the great hope. As a matter of fact, to my way of thinking, it is almost the only hope, where it is highly populated.

It may be important for this group to recognize that many New Jersey leaders in and out of our Government are convinced of our future dependence upon saline water. Six New Jersey communities have applied to the Department of the Interior for an opportunity to provide a site for the demonstration saline plant scheduled for installation on the east coast.

Each community has made it clear that a demonstration plant not only would serve the necessary experimental purposes, but would help solve current water problems at that site. These communities are scattered through the length of the State—in the North where the problem is population, and in the South where the problem is

undependable or brackish wells and a rapidly growing industrial complex.

Within the past few weeks, both houses of the New Jersey Legislature passed a joint resolution pointing out that:

"* * * demonstration of the practicability of various processes for converting salt water to fresh water is an important step in the search for new sources of supply;" and since "many water problem areas already exist in New Jersey where the application of salt and brackish water conversion processes may perpetually provide practical solutions to water shortage problem," the State is anxious to move toward saline conversion experimentally at this time.

Governor Meyner recently wrote a letter to the Secretary of the Interior pointing out:

The pace of economic growth in this region means that new potable water supplies must be found * * * The bulk of the population increase coming in the New York City metropolitan area will center in northern New Jersey. The region between Trenton and Wilmington is one of the fastest growing industrial areas in the Nation. Many water problem areas already exist in New Jersey. The availability of economically feasible surface water storage sites is already a serious problem * * * There is, therefore, a strong public interest within New Jersey in any program, experimental or practical, which gives promise of providing that guaranty.

As further evidence of our deep interest in the necessity and the future of saline conversion, I should like to point out that an agreement has been signed by the Governor and by the Saline Water Division of the Department of the Interior calling for mutual cooperation between our State and the Federal Government in exchanging information and data concerning all phases of the water problem, with special emphasis on salt water conversion. I think we have taken time by the forelock on this, since it is an essential part of the Federal-State cooperation suggested in S. 3557.

In short, we in New Jersey, with recent experience in attempting to solve our water problems, are convinced that our only long-range security lies in salt water conversion. That is our first reason for urging passage of this bill.

The second point I want to make is this: Since the need for practical sea water conversion systems is already urgent in many sections of the country, our saline water development program should be expedited and expanded, and this bill will do it.

Our present program is limited in the amount of money immediately available, in the choice of channels we can explore, and in the financial and governmental facilities we can bring to bear on this problem.

It is important to remember that time works against us two ways on programs such as this: it takes time to develop, prove, and construct practical systems; simultaneously, the overtaxing of water supplies in many places is increasing. All possible hurdles to the practical use of saline water, at the soonest possible time, should be removed.

Our present saline conversion program was instigated as a hopeful solution to an obviously threatening problem. Since its inception, saline conversion has graduated from the proving stage, and about all that remains to be demonstrated is that plants of sufficient capacity to serve a major municipality can be built successfully and can be operated economically.

I say that is all that is to be proved, but that is quite a bit.

I have said that we will soon be faced with the urgent need for another reservoir, or its equivalent, in supplying additional water. In the meantime, we are hoping to get water from the Delaware River under a tristate agreement, but this requires appropriations from Congress, considerable dam construction, and a working agreement among the States involved.

Should anything hold up utilization of the Delaware water, we and two of our sister States would be faced with another critical situation. The question is: Should this happen? Will saline conversion be ready to take its place? It could be.

More money, more talent, and more facilities, as stimpuated in S. 3557, will enable us to accomplish the task in ample time; I am sure of that. Just look at the progress that already has been made with a program limited in funds and scope and facilities.

Now for my third point: Expanded research into all phases of saline water conversion is absolutely essential, and this bill provides for it; but we should now face the fact that sea water conversion is no longer a theory or a possibility; it is no longer an experiment. We are ready for the next chapter.

Relatively small-capacity plants have been installed and are serving successfully several areas, particularly overseas. Present systems are subject to much refinement, and further research can reduce costs; but we know we can convert sea water or brackish water to provide more potable water and relieve shortages.

What we need now are more producing plants. We need installations of such size and capacity that their output of potable water can be put to work in various municipalities.

In our recent New Jersey water referendum, we allocated $3 million for research in various ways to improve our water resources. We even set aside $100,000 to test the practicability of storing water underground. We are working on means to try and see if some of that cannot go toward saline research.

Since that time, however, many of us have come to feel that the real promise lies in conversion, but here we are faced with a serious problem that we cannot solve: What are the actual production costs of sea water in large enough quantities to be sufficient for our needs?

The estimated or projected cost of producing converted sea water in quantity in New Jersey is already comparable with the cost of storing and utilizing surface water, according to figures supplied by the Saline Water Division.

One of our newly authorized reservoirs will supply water at about 18 cents per thousand gallons wholesale, and water from the other will cost considerably more. The Saline Division estimates that a plant with a 50 million gallons per day capacity could produce potable water from the sea for 43 cents per thousand gallons, including all taxes and similar charges normally assessed against private enterprise, which are not paid in our reservoir system.

Removal of these extra costs might lower the price to about 22 cents. That is an estimated 18 cents for reservoir water against an estimated 22 cents for converted sea water.

Capital outlay is another factor of great interest. The capital cost of a large conversion plant was estimated for me last year, before some recent developments which probably would lower the cost

somewhat, to be somewhat less than $50 million for a 50 million gallons per day plant.

Our new reservoir program, producing about 70 million gallons per day, will cost about $35 million. Our capital costs, therefore, are about 50 cents per gallon per day capacity, as against an estimated $1 per gallon per day capacity. A 70 million gallon per day conversion plant would cost less per million gallons, the Saline Division says, but nobody now knows how much less. So we cannot really compare capital costs yet.

Two other interesting factors to be considered with conversion plants are the amount of space required and the speed of construction. A plant of 50 million gallons capacity with 250 million gallons of emergency storage would require about 10 acres. On the other hand, a reservoir with sufficient storage to permit 50 million gallons per day would require many, many times more space.

Moreover, the impounding of streams, the building of dams, and the filling of reservoirs require several years, while conversion plant construction can be completed in a matter of months. This could be a factor of considerable importance, especially if people continue to ignore the water problem until it really catches up with them.

But all this is conjecture. No one has ever built a plant that will produce 50 million gallons a day, let alone 70 million gallons. If someone had, we could sit down and compare costs, and we might find that conversion, developed and perfected no further than it is today, is already a satisfactory substitute for surface water storage.

If so, we could far more profitably set out to plan a conversion unit to meet our next crisis, rather than seek another multiarce site that is certain to cause trouble and dislocation even if we can find it.

"But nobody ever built one that big" is a difficult objection to meet. It casts doubt on all estimates and all projections. It defeats efforts to build one that big. This, I think, should be one of the main targets of this bill.

Finally, my fourth point: The provision in S. 3557 to aid municipalities in setting up conversion installations, through the loan of Federal funds, can be most significant.

There is a scarcity of funds in many communities and there always is, often in the very ones that find themselves in water difficulties, because water scarcity discourages commercial and industrial development, without which a community these days has hard going.

I have recounted also the problems that we had in my State over a period of 30 years in securing public support and public financing for a water referendum. S. 3557 would circumvent much of this possibly serious or disastrous delay.

And finally, I should like to underscore Senator Johnson's words that "Right now, commercial conversion of saline water would probably be cheaper for many communities than obtaining water from natural sources. But these communities understandably hesitate to put money into plants which may, in later years, turn out to be high-cost operations.

Federal assistance, in the form of loans, is necessary to bridge for a few years the gap between experimental plant operation and practical application of conversion plants. Such a program would also help get new plants built and operating, and would add to the stock of technical and cost information and speed the entire program.

Everything in our experience would indicate that there is profound wisdom in this observation. In my estimation, it deserves the greatest consideration of the Congress, as does the entire bill.

With your permission, I should like to file with the committee a slightly expanded version of this testimony containing copies of the documents mentioned.

Senator ANDERSON. Thank you, Mr. Shanks.

Without objection, this additional expanded statement will be filed for the use of the committee in final consideration of the bill.

Senator Allott, have you any questions?

Senator ALLOTT. I believe not. I think this is a very fine statement.

I was particularly impressed by one point in it, and that is the fact that as we move along in this day and age, the time factor of saline plants as against reservoir or the conventional method of conservation of water may become such a vital factor that we would have no choice in the method that we use.

This particular point I thought was one that has not been discussed enough and has not been given enough consideration.

Mr. SHANKS. It is a great factor in the crowded East.

Senator ANDERSON. Senator Moss?

Senator Moss. I compliment Mr. Shanks highly for his statement. It was most interesting and reveals that New Jersey is already encountering a problem and is taking action to meet it. Certainly it argues for the bill that we are considering here.

Senator ALLOTT. I have one other point.

I am not sure whether you are prepared to answer this question, Mr. Shanks, but with respect to the difficulty of securing reservoir sites, I believe New Jersey recognizes the riparian doctrine of water, whereas, we in the West have recognized the doctrine of prior appropriation and various modifications according to the States.

Has the riparian doctrine as it is applied in the East been a major factor in deterring the acquisition of reservoir sites, or are you prepared to answer it?

Mr. SHANKS. It has been a factor in New Jersey, but we think we have solved it. I cannot answer for other States. But you have to solve it by arranging pretty much to keep the average water levels and not getting much below them. But it is a factor which is always involved, particularly where you have industries along your rivers that are water users. I do not think, however, it is insuperable.

Mr. SMITH. On this new reservoir system that we have set up we are using an actual river as the carrier for the water. The water is collected in the reservoir and is sent untreated down this river to the places where the water companies pull it out.

Well, this immediately presented a problem because all the plants and some cities along this river have always used the water and it has been theirs at no cost. This is something that has to be negotiated in each case. It has not been negotiated yet in many cases.

This is a problem. However, it has not been a basic problem in the establishment of our present new reservoirs, in the reservoirs themselves, because they are at places where there was no water before. They are going to be strictly synthetic reservoirs. But it is the car-

riers that we have to use, because we have no place for pipelines, and it does become a problem.

But it is going to be solved by the fact that in the legislation we agree to keep the water level at its mean level over the years at all times. We let water out of the reservoirs in order to raise that level up when the level gets down below.

Senator ALLOTT. I just raise this question, Mr. Chairman, because it appears to me that this might be one additional problem they have to solve because of their legal approach to the rights of people to enjoy the use of water that we do not have in the West.

Mr. SMITH. No one has had an opportunity to really argue this one out in court or otherwise yet. When these reservoirs get operating, then we will be faced with it. I do not know how much trouble it will be.

Senator ANDERSON. Mr. Shanks, the insurance company you head does a great deal of lending. There is reference here to the fact that loans might be desirable from the Federal Government. Would it not be true that if a community of 500,000 people needed to borrow $50 million to build this type of plant that is not completely bomb-proof yet, that it might have a great deal of difficulty floating that paper at reasonable rates of interest?

Mr. SHANKS. Yes; there would be considerable difficulty, because it is experimental and we don't know how soon it will be obsolete and all that sort of thing.

Senator ANDERSON. Whereas, if the Government had some sort of guaranteeing facility, as it had in the Allott bill or in this bill, the rate of interest might be substantially lower?

Mr. SHANKS. That is entirely true. Of course, I am a great believer in private enterprise and private lending. But in places like this, in cases where the research can be done by the Government at much less cost and expanded to the point where private lending can take over later, it would be better.

Senator ANDERSON. That might make the plant more feasible in the beginning and then as modifications and processes make future plants more efficient, they might be scattered all across the country and there might be avenues for private lending which would be very difficult today.

Mr. SHANKS. That is right.

Senator ANDERSON. Thank you for your testimony of today.

Mr. SHANKS. Thank you.

Senator ANDERSON. The next witness is Mr. Sheppard T. Powell. I know of your interest in this field, and I compliment you for the work you did in the special committee.

Mr. POWELL. Thank you.

Mr. LINEWEAVER. I would like to say that Mr. Powell has been a consultant on the saline-water program since its inception in 1952. Mr. Chapman appointed him as one of the consultants early in the game, and he has been of great service to the program.

Mr. POWELL. Thank you.

Senator ANDERSON. I am sure what Mr. Lineweaver has said is echoed by all of us. You have a fine record and we will appreciate it.

STATEMENT OF SHEPPARD T. POWELL, CONSULTING ENGINEER, BALTIMORE, MD.

Mr. POWELL. Thank you.

My name is Sheppard T. Powell. I am senior partner of the firm of Sheppard T. Powell & Associates, consulting engineers of Baltimore, Md.

As has already been stated, I have been adviser on the salt-water conversion activity or program since its initiation in 1952.

Mr. Chairman, I have a brief statement. It looks more voluminous than I will read, but much of it is statistical data which will be in the record for your use.

Mr. Chairman and members of the committee, I appreciate the opportunity to discuss this bill because of its great importance to the welfare of the country.

I would like to go on record that I strongly support the statement in the preamble of the bill that—

> * * * a serious problem exists in many areas of the country today because natural fresh water supplies have remained relatively constant while population and the consumption of fresh water have increased tremendously.

It is reliably predicted that by 1980 the total demand for fresh water in the United States will reach from 494 billion to as high as 595 billion gallons daily. The uninformed public has little conception of this dramatic condition.

To illustrate, in the Houston, Tex., area the population increase in 50 years was 278 percent, while the demand for water in the same period increased 7,000 percent. (Ernest R. Abrams: "Is Texas Running Dry?" Public Utility Fortnightly, 45:79, Jan. 19, 1950.)

Similar conditions are occurring in many areas to a greater or lesser degree, especially in regions which are highly industrialized.

Much misinformation has been circulated regarding the actual and potential water resources in the country that needs correcting. The extensive factual data assembled and recently published by the Select Committee on National Water Resources, of which Senator Kerr is chairman, should counteract both complacency and hysteria as to the future water demands and how these requirements may be met by long-term constructive planning.

The legislation proposed in S. 3557 will contribute in no small measure to the solution of furnishing adequate water of acceptable quality to many areas which are now, and will be, economically and socially retarded if relief is not forthcoming in the immediate future.

We have recently made a survey of the saline water from wells and a limited number of surface sources in the States of Texas, New Mexico, Arizona, South Dakota, North Dakota, and Montana.

I may interject here that this is a personal investigation and not part of the Office of Saline Water.

These analyses have been recorded from data supplied by the department of health of each of the States, and are appended hereto. The record revealed that there are more than 566 saline ground water supplies in these areas having total dissolved solids ranging from 1,000 parts per million to more than 4,000 parts per million. A breakdown of these data is shown on the accompanying table.

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In addition to the States listed, there are extensive areas now suffering from fresh water shortages where there are enormous volumes of saline water from both ground water and surface supplies that are unusable because of the high concentration of dissolved solids. Conversion of these supplies to usable fresh water would solve these local problems.

The record presented does not represent the total available supplies, but only a small fraction of the gross volume of saline water which, no doubt, is extensively distributed and still untapped. An urgent need at present would be a nationwide study to identify and determine the potential saline supplies, both as to locations and volumetric capacities of both surface and ground waters.

The U.S. Public Health standards specify a satisfactory water for domestic and other useful purposes as follows:

Total dissolved solids:	*Parts per million*
Acceptable	500
Top limit	1,000

It is obvious that a large group of people are forced to use water in excess of these concentrations, but water much in excess of 1,000 parts per million may be totally unacceptable.

The data presented herein are merely indicative of the location of the saline water sources, but reveal no specific information on the enormous volume of water available by tapping and utilizing the extensive saline water aquifers.

From my personal knowledge, many of the wells are free flowing to the extent of untold millions of gallons of water per day. Recently we visited one community where salt water was abundant, but where water was being hauled nearly 100 miles to supply the citizens with drinking water. It was freely admitted that the business expansion of the community will be indefinitely retarded unless the water supply problem can be solved.

It is generally believed that the production of usable fresh water by conversion processes is limited to seacoasts, using full-strength sea water. It is true that the greatest worldwide application may be conversion of sea water, but this is by no means the complete usefulness for solving or minimizing the shortages of water as related to the full use of saline supplies.

As is evidence by the tabulated record, there are extensive areas throughout the high plains regions in Midwestern States and through the Southwest in this country where there are voluminous quantities of surface and ground water which are not acceptable supplies because of their total dissolved solids.

In practically all tidal waters the salinity of the water varies widely during the seasons. Not only does the salinity vary as the runoff is reduced, but the penetration of salt and admixture with the fresh water of the stream will vary from high to low tides. This is a condition that is typical of many tidal streams.

Similar conditions exist in many inland streams subject to natural or industrial pollution, as the Brazos River in Texas. This is particularly the case in areas where salt water from oilfield drainage, either intentionally or accidentally, reaches the surface and ground water supplies.

Up to the present, little interest has been aroused in the application of desalting methods to solve water problems occurring in areas where conditions are such as those described.

It is obvious that a water containing a few parts per million of dissolved solids is not necessary for sanitary purposes, nor for many industrial uses. Demineralized water, practically free of dissolved solids, as is obtainable from evaporators or freezing methods, may be produced from brackish supplies and then can be used as a diluent for the original brackish water, thereby increasing total output.

It follows therefore, that if the cost of producing water from an evaporator or other process, including all charges, were $1 per thousand gallons, and if it were diluted one to one with the raw water supply, a usable water might be produced at a cost of 50 cents per thousand gallons, or less.

These comments are presented primarily to create provocative interest in phases of saline water conversion which, up to the present time, have been largely ignored.

It is my opinion that the provisions of the bill to continue to assign the administration of the project to the Office of Saline Water, under the direction of the Secretary of the Interior, is wise. From my close association with the Office of Saline Water, as an adviser to the program, I have been afforded firsthand knowledge of its administration and its accomplishments.

The administrative work of the Office has been most efficient, and the excellent quality of its numerous reports and other releases is creditable. These have been widely distributed and contain much factual data and other valuable information to guide the national water policy now being formulated.

My personal contact with large groups of people throughout the country has strengthened and confirmed this opinion because of the many unsolicited commendatory statements which have been made to me.

To summarize, I strongly urge that this bill be approved as essential and constructive legislation. Our national water problem has now reached a sufficiently critical state where all sources of water must be evaluated and made available, not the least of which is the highly mineralized water. Conversion of such water to usable fresh water can do much to minimize water shortage.

I have included here a great number of data. I will not attempt to present them here. I would like to summarize briefly a summary table here.

There are 566 of these waters in the States I have mentioned. For instance, in Texas there are 176 supplies that are above 1,000 parts per million. That is 79 percent of the total water in these wells which is above 1,000 parts per million.

In South Dakota there are 217 of them, of these waters. In North Dakota there were 82; in Arizona, 32; in Montana, 45; in New Mexico, 17.

I would like to make clear that these are not the total saline resources in those States. Those are the ones that we now have available. But I believe, and I would like to stress this again, there are enormous quantities of these ground waters in saline supply and also great

quantities of saline water in surface streams which no attempt has been made to use.

Thank you.

Senator ANDERSON. Thank you very much for the statement and for its compactness. I think you made one very interesting comment and that was that if we had desalinized some waters we might mix it with other waters and come out with an average cost that would make it attractive.

Mr. POWELL. Yes, sir.

Senator ANDERSON. Senator Moss, have you any questions?

Senator Moss. No questions, Mr. Chairman.

Senator ANDERSON. Thank you very much for appearing here, Mr. Powell.

Your charts will appear in the record at this point.

(The material referred to follows:)

Summary of the analyses of saline waters in Texas, Southwest, and Great Plains States

State	Total dissolved solids (parts per million)								
	Over 1,000 (number)	1,000 to 1,500		1,500 to 2,000		2,000 to 3,000		Above 3,000	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Texas	176	79	46	45	25	36	20	17	9
South Dakota	214	58	27	56	26	95	45	5	2
North Dakota	82	35	43	18	22	22	27	7	8
Arizona	32	18	55	4	12	10	30	1	3
Montana	45	25	55	10	23	8	17	2	5
New Mexico	17	8	47	5	29	3	18	1	6

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SUBJECT Municipal Raw Water Supplies High in Dissolved Solids -- Data from U.S.G.S., "The Industrial Utility of Public Water Supplies in the United States, 1952 (West of the Mississippi River)"

JOB NO._____

TOWN AND STATE	SiO_2	Fe	Mn	Ca	Mg	K&Na	CO_3	HCO_3	SO_4	Cl	F	NO_3	TDS	Hard	NCH
Douglas, Arizona	21	.28	---	6.2	2.4	327	21	130	183	288	3.2	1.8	930	25	0
Phoenix, Arizona	27	.03	---	77	56	147	0	270	123	222	0.6	98	887	422	202
Tempe, Arizona	27	.21	---	95	37	264	0	450	103	338	0.2	14	1100	389	20
Winslow, Arizona	6.3	.03	---	44	27	346	7	210	42	525	0.1	2	1110	231	55
Hope, Arkansas	8	.16	---	3.4	1.2	423	28	517	44	292	0.3	0.2	1060	14	8
Oxnard, California	---	0.8	---	197	61	93	0	248	625	61	0.7	2.4	1160	745	540
Ventura, California	42	1.2	---	159	47	161	---	392	484	71	0.3	---	1160	591	269
Esther, Iowa	19	1.7	0	156	59	68	0	332	483	3.5	0.4	5.6	1010	632	360
Havre, Montana	19	0.15	---	83	48	238	0	522	443	29	0.6	0.8	1120	138	0
Carlsbad, New Mexico	15	---	---	159	49	114	0	262	390	158	---	3.0	1020	598	384
Las Cruces, New Mexico	32	0.13	---	196	34	179	0	439	401	153	0.1	7.8	1260	629	270
Portales, New Mexico	51	0	---	123	45	109	0	209	358	117	1.7	7.6	952	492	320
Roswell, New Mexico	15	0	---	187	48	126	0	219	486	185	0.7	6.7	1160	664	484
Dickinson, North Dakota	12	.05	---	9	7	580	---	911[1]	528	7	0.2	0.5	1600	51	0
Grafton, North Dakota[2]	11	.78	0	49	28	1778	0	867	618	1940	2.8	18	4880	238	0
Minot, North Dakota[2]	26	2.6	.04	86	29	365	0	789	120	240	0.2	3.0	1280	334	0
Chickasha, Oklahoma[2]	15	0	---	196	63	83	0	322	529	79	0.1	0.1	1120	748	484
Ponca City, Oklahoma	---	---	---	121	97	132	0	486	361	126	---	44	1120	701	303
Madison, South Dakota[2]	22	.49	.79	161	63	75	0	304	448	70	.2	.3	1060	662	413
Vermillion, South Dakota	34	2.6	.56	182	53	92	0	627	335	8.5	.6	.2	1040	673	159
Alice, Texas	18	.05	---	43	23	410	0	315	165	448	.9	22	1290	202	0
Dallas, Texas[3]	22	.02	0	6	2.2	386	0	542	259	95	1.8	.5	1040	24	0
Galveston, Texas	---	---	---	54	11	545	0	338	2	770	---	---	1550	180	0
Garland, Texas	25	.02	---	3.9	0.9	437	25	468	370	97	1.8	.8	1170	13	0
Harlingen, Texas	11	0	0	92	33	205	0	149	274	284	.8	.5	1000	365	243
Kingsville, Texas	11	.02	---	24	9.6	317	0	304	163	255	.4	12	959	100	0
Lubbock, Texas	---	---	---	78	96	160	0	423	379	126	3.2	11	1200	589	242
McKinney, Texas	20	.09	0	15	5.6	444	0	400	371	205	0.9	2	1290	60	0
Midland, Texas	68	.03	0	242	156	397	0	255	814	698	3.6	28	2790	1250	1040
Temple, Texas	14	.01	0	6.8	4	438	0	442	221	268	2.2	3.5	1180	34	0
Waxahachie, Texas	22	.05	---	4.0	1.6	462	6	520	167	288	1.8	0	1210	16	0
Ogden, Utah	25	.09	---	120	33	248	0	162	12	595	.2	.7	1120	435	302
Worland, Wyoming	25	.10	.12	143	47	173	0	411	505	36	.7	16	1150	552	215
Sarasota, Florida	24	---	---	196	151	57	---	149	824	180	---	---	1500	1110	988
Galesburg, Illinois	10	0.6	0	113	53	432	0	263	930	184	---	1.6	1850	501	285
Kewanee, Illinois	14	0.3	0	97	36	474	---	283[4]	278	640	0.8	0.9	1700	389	157
Biloxi, Mississippi	18	0.03	0	6.5	1.0	405	0	335	0.4	432	0.3	1.2	1030	20	0
Plainfield, New Jersey	---	0	---	---	---	---	---	106	---	16	0.3	0.8	1080	650	563
Marion, Ohio	15	0.08	0.07	176	52	20	0	375	370	5.8	1.3	0.1	882	653	346

(1) As Alkalinity (2) Finished Water (3) Most of water from Trinity River (4) Total Alkalinity as HCO_3

NOTE: Quantities expressed in parts per million, except pH.

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SUBJECT Municipal Raw Water Supplies High in Dissolved Solids -- Data from Miscellaneous Sources

JOB NO. ____

TOWN AND STATE	SiO_2	Fe	Mn	Ca	Mg	K&Na	CO_3	HCO_3	SO_4	Cl	F	NO_3	TDS	Hard	NCH
Devils Lake, North Dakota	---	0.15	---	12.4	4.1	1440	---	880	1145	850	3.0	86.7	4422	48	---
Safford, Arizona	---	---	---	126	36	1110	0	532	600	1277	---	---	3701	463	27
Louisville, Kentucky[5]	18	5.6	2.3	264	79	32	---	534	531	30	0.1	0	1264	985	546
Dillonvale, Ohio[6]	6.1	0.4	---	266	96	146	---	77	1160	61	0.4	1.0	2110	1060	995
Phoenix, Arizona[7]	32	0.06	0.02	461	197	640	---	368	1060	1310	0.5	52	4040	1960	1658
Miller, South Dakota[8]	15	1.5	0.06	195	61	351	---	188	1120	83	2.4	1.0	1950	739	585
Grants, New Mexico	23	---	---	115	50	161	---	299	560	10	---	---	1218	494	249
Eureka, South Dakota[9]	---	1.8	0	344	106	174	---	207	1319	66	3.6	0	2462	1299	1129
Webster, South Dakota[9]	---	1.3	0.7	206	77	99	---	315	733	9.7	0.6	0.6	1509	827	569
Ellendale, North Dakota[9]	---	---	---	---	---	1138	---	494	154	1190	---	---	3040	---	---

(5) U.S.G.S. Survey Circular 276, page 35

(6) U.S.G.S. Survey Circular 340, page 14

(7) Twenty miles west of Phoenix (Ionics Inc.)

(8) Ionics Inc.

(9) O.S.W.

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SUBJECT ARIZONA -- Summary of the Chemical Analyses of Arizona Community Water Supplies - March, 1960

JOB NO.____

TOWN	Total Solids	Alk.	Hard.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Elgin	1167	144	795	215	62	25	.29	.05	680	6	.77	2.5	Well
Portal	1175	126	830	284	29	28	.05	.05	610	4	1.10	1.0	Well
Willcox	1442	276	1	1	1	495	.05	.05	240	420	11.60	1	Well
Payson	1019	234	720	174	68	33	.05	.05	475	10	.27	1	Spring
Ft. Thomas	1493	130	685	208	41	190	.28	.05	165	480	.45	8	Well
Pima	2229	348	740	160	82	455	1.10	.05	315	740	1.80	48	Well
Buckeye	2228	56	920	256	67	317	.41	---	255	810	1.84	35	Well
Gila	1033	33	40	18	--	365	.05	.05	128	475	7.40	10	Well
Glendale	1206	150	605	126	70	50	.05	.05	18	298	.26	220	Well
Litchfield Park	2271	128	1285	292	133	236	.20	.05	715	590	.60	59	Well
Mesa	1305	136	460	138	28	220	.147	.05	60	515	.66	60	Well
Phoenix	2766	337	1040	252	98	470	.05	.05	135	980	.15	135	Well
Tempe	1985	124	660	172	55	320	2.00	.05	330	640	.12	16	Well
Tolleson	3631	413	760	160	86	1000	.05	.05	700	1120	1.40	625	Well
Youngtown	1131	184	620	192	34	49	.33	.05	78	340	.06	33	Well
Holbrook	1615	460	140	44	7	550	.294	.29	178	500	.95	3	Well
Joseph City	1335	200	290	56	36	370	.05	.05	165	540	.60	1	Well
Winslow	1053	200	395	80	47	235	.05	.05	110	390	.13	4	Well
Page	1297	108	572	154	44	152	.11	.05	580	128	.41	6.3	Well
Tucson	2207	360	800	232	53	390	.05	.05	1000	160	1.92	54	Well
Apache Junction	1533	142	300	77	26	375	.70	.05	184	750	2.40	7	Well
Casa Grande	2522	152	1125	346	62	320	.16	.05	840	560	.40	36	Well
Coolidge	1620	160	684	208	39	240	.05	.05	440	400	.92	27	Well
Maricopa	1445	138	610	192	29	135	.15	.05	190	440	.40	30	Well
Ray	2296	460	1220	336	91	250	.05	.05	930	105	1.12	5	Well
Black Canyon	2263	1430	158	31	19	770	.16	.05	130	210	4.00	1	Well
Camp Verde	1471	460	740	113	110	200	.20	.05	500	140	.49	4.8	Well
Ehrenberg	1416	257	270	80	17	390	.40	---	390	341	1.80	1	Well
Parker	1439	136	460	144	24	250	.56	.05	410	350	2.12	46	Well
Somerton	1474	224	680	192	48	220	.44	.55	400	347	.38	1	Well
Wellton	2588	172	860	192	91	475	.05	.42	215	1060	1.34	10	Well
Yuma	1286	47	92	34	1	430	.50	.05	275	545	5.40	2	Well

NOTE: Quantities expressed in parts per million.

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SUBJECT Municipal Well Supplies of Montana (Over 1000 ppm TDS) JOB NO____

MUNICIPALITY	Total Solids	Hardness	Ca	Mg	CO_3	HCO_3	Cl	SO_4	Na & K
Bainville	2295	1380	258	179	0	460	98	1146	152
Bainville	2495	970	188	122	0	793	10	1204	421
Baker	1040	7	3	0	54	520	10	271	372
Belt	1070	780	204	66	0	360	15	444	15
Big Sandy	2990	396	62	59	0	865	189	1335	913
Brady	1060	550	63	96	0	284	18	555	133
Broadview	3785	86	22	7	0	1604	27	1550	1334
Chester	1985	31	6	4	24	494	66	995	712
Circle	2230	124	20	18	0	522	24	1056	663
Circle	1955	54	8	9	0	804	24	805	660
Culbertson	2200	648	153	65	0	708	64	1052	524
Fort Belknap	2040	46	11	4	30	799	220	590	735
Fromberg	1485	980	240	93	0	323	10	778	54
Geraldine (Spring)	1515	760	176	78	0	378	22	749	127
Glasgow	1095	428	102	42	0	424	13	358	147
Glendive	1075	7.5	1	1	51	667	34	160	388
Harlowtown	1025	25	5	3	18	622	15	255	370
Harlowtown	1330	131	26	16	0	531	31	531	416
Havre	1170	262	62	26	0	531	42	404	302
Hingham	1965	15	3	2	30	934	636	2	813
Hinsdale	1440	596	136	63	0	519	27	643	250
Hysham	1240	275	56	33	36	494	12	467	---
Judith Gap	1345	148	25	21	0	366	58	637	408
Kremlin	2500	38	6	3	0	1087	360	625	938
Lodge Grass	1140	20	4	2	0	479	13	473	408
Lodge Grass	1455	13	3	1	0	487	14	679	513
Medicine Lake	1180	380	109	26	0	516	24	474	271
Melstone	1680	654	220	25	0	384	19	834	255
Musselshell	1180	343	61	47	0	430	18	518	261
Nashua	1600	609	160	51	0	452	21	722	254
Plentywood	1920	940	130	150	0	482	39	886	215
Plentywood	1810	24	5	3	67	846	193	372	625
Richey	1155	12	2	1	24	1094	77	0	459
Richey	2030	994	168	140	0	729	13	914	279
Rudyard	1145	12	2	2	84	857	95	7	448
Ryegate	1515	756	158	88	0	495	29	682	188
Saco	3255	960	186	121	0	409	164	1750	645
Sunburst	1025	290	55	41	0	488	11	247	170
Sunburst	1050	13	1	2	54	614	39	273	430
Wibaux	1295	46	7	7	0	562	7	492	428
Wibaux	1265	50	6	8	23	546	8	515	454

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SUBJECT Municipal Well Supplies of Montana (Over 1000 ppm T D S)

JOB NO.____

MUNICIPALITY	Total Solids	Hardness	Ca	Mg	CO_3	HCO_3	Cl	SO_4	Na & K
Winnet	1065	78	4	17	0	650	82	193	355
Winifred	1520	520	117	55	0	473	24	757	328
Wolf Point	1000	208	43	24	0	536	11	343	280
Wolf Point	1025	210	45	24	0	650	16	279	144

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SUBJECT NEW MEXICO -- Chemical Analysis of Water Supplies, Department of Public Health, Santa Fe -

JOB NO. ___

TOWN	pH	T.S.	NO_3	Alk.	CO_3	HCO_3	Cl	Na	Ca	SO_4	F	Mg	Fe	T.H.	Source
Lumberton	8.6	1950	---	1234	0	1234	154	598	5	87	0.8	1.75	.017	20	Well
Chimayo	6.6	1092	.35	640	0	640	10	74	200	197	1.6	20.5	0.9	584	Well
Gallop	8.5	1352	0	180	0	180	28	50	33	131	0.48	33	0	216	Well
Capitan	7.2	3120	0.44	356	0	356	408	57.5	480	880	0.8	112	0.8	1660	Well
Alomogorda (No. 2)	7.8	1968	0.35	200	0	200	424	218	237	495	.18	55	0.2	817	Spring
Tularosa	8.0	1588	2.2	138	0	138	88	67	260	796	.56	67	0	924	River
Santa Rosa	7.7	1062	0	94	0	94	8	16	230	616	.13	28	0	690	River
Dexter	7.1	1890	1.7	182	0	182	78	71	300	958	0.7	87	0	1106	Well
Lake Arthur	7.4	2336	6.2	150	0	150	103	60	375	1161	0.61	100	0	1349	Well
Roswell	7.5	1082	1.7	196	0	196	181	99	195	454	0.58	45	0	672	Well
Hagerman	7.2	1200	2.6	164	0	164	43	21	195	550	0.6	57	0	721	Well
Artesia	7.5	1022	1.7	208	0	208	16	21	185	501	0.7	51	0.2	682	Well
Carlsbad	7.4	1320	2.6	230	0	230	161	4.6	173	244	0.4	56	0	659	Well
Koehler	7.5	2072	0.44	368	0	368	44	196	203	849	0.16	76	0	818	*
San Jon	8.1	1720	8.8	480	0	480	197	597	48	821	3.78	24	0	217	Well
Elida	8.1	2944	0	305	0	305	346	492	133	1188	7.18	140	0	905	Well
Los Cruces	7.3	1260	7.8	---	0	439	153	---	196	401	0.10	34	0.13	629	---

* Infiltration Gallery

NOTE: Quantities expressed in parts per million, except pH.

NOTE: Quantities expressed in parts per million, except pH.

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SUBJECT NORTH DAKOTA -- Chemical Analyses of North Dakota Municipal Water Supplies

JOB NO.____

TOWN	Total Solids	Alk.	Hard	Fe	pH	Ca	Mg	Na	F	Cl	SO_4	HCO_3	NO_3	CO_3	Source
Alexander	1634	464	471	2.3	7.8	92	57	288	.03	30	600	575	---	---	Well
Amenia	2514	272	240	.85	8.3	65	19	730	.85	406	909	332	52	---	Well
Ashley	1044	284	252	5.10	---	77	14	206	.15	28	362	346	4.4	---	Well
Beach	1078	328	508	.75	8.0	72.2	79.5	84	Tr.	18	421	400	2.1	---	Well
Belfield	2210	734	270	.58	7.8	52	34	706	---	10	1005	895	Tr.	---	Well
Bottineau	1018	341	681	2.60	7.3	130	87	40	---	2	412	415	---	---	Spring
Bowbells	2639	1424	727	3.20	7.9	62	137	365	.90	325	---	1742	---	---	Well
Bowman	1092	630	10	.10	8.6	4	---	445	1.00	25	232	638	---	---	Well
Casselton	2760	298	36	.15	8.0	7.2	4.4	851	3.80	330	1129	364	---	13.2	Well
Cogswell	2601	260	80	.40	7.8	22	6.1	835	7.00	290	1170	239	Tr.	Tr.	Well
Columbus	2840	1645	11	.15	8.2	3.2	.7	917	3.00	245	11	2005	---	---	Well
Cooperstown	1852	232	736	.62	7.9	173	74	275	Tr.	50	993	283	4.3	---	Well
Crosby	1814	1036	212	2.30	8.0	38.8	27.9	420	.70	62	Tr.	1262	---	---	Well
Devil's Lake	4095	678	64	.32	8.8	11.6	8.5	1360	3.60	840	1105	705	4.3	60	Well
Drake	1922	782	20	.60	8.1	8.0	Tr.	655	.10	256	45	955	2.1	---	Well
Dunseith	1189	566	30	0	8.6	7.2	2.9	259	---	82	177	633	Tr.	28	Well
Edgeley	1186	402	326	1.50	8.0	79.3	31.1	229	Tr.	156	193	491	4.3	---	Well
Elbowoods	1515	366	104	1.00	8.7	26.4	9.3	477	---	202	373	298	4.3	24	Well
Ellendale	3040	456	56	.70	8.6	12.0	6.0	1138	1.05	1190	154	494	13.0	31	Well
Elliott	2471	212	112	1.10	---	16.8	17.0	620	7.00	350	1205	259	2.1	---	Well
Enderlin	1422	368	576	.40	7.3	154.5	46.0	188	---	22	572	437	2.1	---	Well
Fessenden	1256	801	372	1.30	7.5	89.0	72.0	271	---	4	292	978	52.0	---	Well
Finley	1097	292	484	4.60	7.2	103.8	54.6	129	Tr.	24	422	356	2.1	---	Well
Flasher	1606	516	12	.35	8.8	4.8	---	495	.90	8	536	434	4.4	72	Well
Flaxton	1930	658	32	.58	7.9	13.0	---	611	.30	488	15	802	Tr.	---	Well
Forbes	2706	696	84	1.20	8.3	10.8	14.0	917	6.00	850	174	625	4.3	110.4	Well
Forman	1842	414	788	.10	7.2	224.0	54.3	260	---	71	800	505	---	82	Well
Fullerton	2738	480	120	.30	8.7	24.8	14.1	995	1.30	1190	15	488	10.9	48	Well
Gackle	1344	248	428	.30	7.6	97.0	45.2	238	---	36	620	303	4.3	---	Well
Garrison	1947	748	688	3.50	7.6	76.0	119.0	500	.07	13	307	914	8.7	---	Well
Glen Ullin	3197	1116	14	1.60	8.5	5.6	---	950	.90	12	911	1274	---	43.2	Well
Goodrich	1183	740	12	.20	8.9	4.8	Tr.	346	.50	20	5	715	4.6	86.4	Well
Grafton	5767	746	220	.90	8.5	49.0	24.0	1982	.90	1880	740	837	217.0	36.0	Well
Hankinson	1254	485	870	1.32	7.5	114	142	20	---	5	453	593	Tr.	---	Well
Harvey	1648	568	378	.17	8.1	91	37	321	.40	64	404	693	4.3	---	Well
Hebron	2818	884	32	1.60	8.6	7	3.5	850	.30	10	978	903	2.1	62.4	Well
Hettinger	1485	710	166	.18	8.5	15.5	31.0	460	2.20	152	---	784	Tr.	40.8	Well
Hillsboro	1470	268	500	2.65	8.0	126	69	224	.30	180	498	327	43.4	---	Well

NOTE: Quantities expressed in parts per million, except pH.

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SUBJECT NORTH DAKOTA -- Chemical Analyses of North Dakota Municipal Water Supplies

JOB NO._____

TOWN	Total Solids	Alk.	Hard	Fe	pH	Ca	Mg	Na	F	Cl	SO_4	HCO_3	NO_3	CO_3	Source
Hope	1617	352	1060	.95	7.2	245	109	52	---	24	753	429	4.3	---	Well
Jamestown	1120	462	400	2.70	7.7	104	34	157	.10	37	218	565	2.1	---	Well
Kenmare	1669	920	96	.70	8.9	17.6	12.6	460	1.10	128	Tr.	922	4.3	74.4	Well
Killdeer	2236	722	376	1.90	7.6	85	40	506	.15	10	712	881	2.1	---	Well
Lakota	2347	560	346	.70	7.9	38	61	575	.25	124	865	683	Tr.	---	Well
Leeds	3442	700	80	.30	7.9	20.2	8.9	1015	.90	150	1110	855	28.2	---	Well
Lehr	1502	448	380	Tr.	7.7	113	24	295	---	88	432	546	4.3	---	Well
Lidgerwood	1106	480	344	5.8	7.6	102	22	303	.10	31	469	587	4.3	---	Well
Linton	1076	458	472	.80	7.5	118	43	222	---	44	416	558	---	---	Well
Lisbon	1517	448	76	.65	8.5	10	13.6	442	---	142	379	498	4.3	24	Well
Marmarth	2108	508	20	.20	8.5	5.2	1.7	627	Tr.	24	860	552	4.3	33.6	Well
Mayville	1065	314	524	.70	8.0	132	47.1	101	Tr.	28	373	383	---	---	Well
Max	2430	636	812	5.50	8.0	117	126	394	---	14	889	776	108	---	Well
McClusky	1297	650	166	.75	7.6	44.8	12.8	408	.30	280	9	793	Tr.	---	Well
Minot	1000	580	350	2.70	7.9	98	31	215	.10	125	Tr.	700	---	---	Well
Monango	2675	520	112	2.60	8.5	14	18.7	926	1.30	1120	25	487	8.7	72	Well
Mooreton	2420	230	252	1.50	8.3	63.6	22.6	693	1.00	336	1002	295	4.3	---	Well
Mott	1198	1016	11	.30	9.1	4.4	---	517	1.20	16	38	1240	---	---	Well
Napoleon	1058	512	152	.20	8.1	36.1	15	228	---	Tr.	45	625	108.2	---	Well
New England	2241	1268	14	1.00	9.0	5.6	Tr.	650	.90	34	---	1420	Tr.	129.6	Well
New Leipsig	2082	1268	14	.50	9.2	5.6	Tr.	628	.50	66	Tr.	1170	20.6	184.8	Well
New Rockford	1348	620	176	2.60	---	19.6	30.8	322	.15	82	134	755	2.1	Tr.	Well
New Salem	1933	962	14	.10	8.7	5.6	Tr.	560	1.00	6	218	1030	43.4	69.6	Well
New Town	1459	636	496	4.20	7.2	100.1	59.5	212	---	Tr.	308	776	Tr.	---	Well
Noonan	2489	1460	8	1.00	8.8	2.6	Tr.	725	2.50	88	Tr.	1565	Tr.	105.6	Well
Northwood	1040	298	244	.25	8.1	49.0	30	227	.20	140	227	364	---	---	Well
Parshall	2164	780	168	1.50	8.4	38.8	17.3	575	.20	16	615	845	2.3	52.8	Well
Portland	1387	456	684	Tr.	7.4	167	65	127	---	48	408	569	2.1	---	Well
Powers Lake	1592	590	144	3.5	7.6	20.1	22.7	408	---	8	346	720	65	---	Well
Ray	1214	446	700	6.4	7.9	141	84	64	.10	10	363	545	4.3	---	Well
Reeder	1380	760	6	1.0	8.9	2.4	---	414	1.40	104	Tr.	790	67.2	---	Well
Regent	3168	1866	12	1.0	8.3	4.4	Tr.	844	.70	28	Tr.	2221	43.4	26.4	Well
Richardton	1076	278	562	2.0	7.7	102	75	136	.10	6	418	339	---	---	Well
Rolla	1414	264	360	4.8	8.1	68.5	42.8	282	---	12	664	322	8.6	---	Well
Rugby	1333	300	748	3.5	7.2	201	59.8	69	Tr.	46	586	366	2.1	---	Well
Scranton	1363	664	3	.15	9.0	1.2	---	418	1.20	40	147	664	Tr.	92	Well
Sheldon	2739	154	428	1.50	7.7	123	29	857	2.10	316	1215	188	8.6	---	Well
Stanley	3528	906	107	.38	7.7	24.2	11.4	1020	---	---	1365	1108	Tr.	---	Well
Turtle Lake	1740	906	278	.40	8.4	24	53	301	.8	290	---	1040	Tr.	31.2	Well
Underwood	1238	412	794	.35	7.2	209	66	---	---	142	123	503	---	---	Well
Valley City	1037	368	356	.20	7.9	63	48	218	---	28	169	449	2.1	---	Well
Verona	2378	260	60	1.60	8.5	19.2	3	748	5.0	168	1145	259	43.4	28.8	Well
Wahpeton	1269	424	22	.78	8.5	4.8	2.4	383	2.2	94	268	495	Tr.	19.2	Well
Westhope	1543	656	52	.38	8.1	17.6	1.9	445	---	142	132	800	4.3	---	Well

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SUBJECT Water Supply Data, State of South Dakota, Department of Health, March 1959

JOB NO_____

TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Alcester	350	7.3	864	212	82	427	583	0	0	21	12	0.4	2.5	1270
Alexandria	396	7.5	1314	328	119	483	1068	3.2	0.3	107	20	1.0	0	2106
Alexandria	410	7.1	1352	29	148	500	1058	3.4	0.6	115	2	1.8	1.5	2092
Alpena	126	7.2	660	176	52	154	1230	2.2	0	415	87	2.1	0	2120
Alpena	144	7.2	782	214	59	176	1233	3.0	0	380	90	2.3	0	2149
Andover	364	7.8	904	190	104	444	834	0.7	0.5	178	29	0.4	0	1726
Andover	332	7.7	898	187	104	405	868	1.6	0.6	185	20	0.4	2.0	1742
Arlington	396	7.4	395	99	35	483	927	2.5	0	595	189	0.6	6.0	2146
Arlington	360	7.3	422	110	35	439	979	1.8	0	552	173	0.6	12.0	2175
Armour	290	7.7	215	58	17	354	703	0.4	0	537	245	1.2	0	1767
Armour	316	8.0	237	62	19	386	697	0.7	0	537	259	1.2	0	1798
Armour	284	7.5	225	58	19	347	699	0.3	0	537	252	1.2	1.5	1774
Ashton	150	7.6	752	203	59	183	1258	1.4	0	375	75	2.2	0	2178
Ashton	186	8.1	426	112	35	227	1159	2.1	0	587	212	2.4	0	2285
Ashton	180	7.2	366	99	29	220	1137	1.1	0	604	198	2.6	3.0	2258
Avon	202	7.5	712	175	66	246	1340	1.3	0	486	87	1.0	3.0	2318
Avon	200	7.7	742	181	70	244	1322	1.0	0	482	84	0.9	3.5	2323
Baltic	294	7.7	1023	257	92	359	775	0.3	0.2	56	22	0.7	5.0	1567
Bancroft	330	7.7	51	14	4	403	980	0	0	739	223	3.6	2.0	2224
Big Stone City	382	7.3	803	202	72	466	431	0.4	0.1	21	8	0.2	2.0	1105
Big Stone City	412	7.2	961	253	79	503	559	1.0	0.5	32	5	0.3	0.9	1310
Bison	682	8.1	18	3	2	832	3.0	0	0	487	252	1.4	0	1190
Blunt	288	7.5	628	162	54	351	279	0	1.2	175	277	0.1	3.0	1314
Bradley	318	7.7	1217	215	165	388	1123	0.4	0	135	10	0.4	0	2197
Bradley	274	7.5	1532	260	214	334	840	1.3	0	245	334	0.8	115	3186
Brandt	326	7.1	1367	372	103	398	1086	6.5	1.5	64	6	0.6	0	2057
Brentford	230	8.0	61	20	2	281	1114	0.8	0	747	198	3.0	0	2218
Brentford	214	7.5	63	21	2	261	1119	2.0	0	744	198	3.0	2	2240
Bridgewater	356	7.5	651	174	52	434	577	0.1	2.4	156	7	0.5	0	1277
Bridgewater	346	7.6	662	170	56	422	583	1.1	2.2	158	15	0.8	0.9	1270
Bridgewater	338	7.6	908	216	88	412	757	0.6	0.9	125	13	0.4	0.7	1605
Bridgewater	324	7.8	897	200	96	395	824	0.3	0.5	145	12	0.4	0.9	1675
Bridgewater	289	7.6	871	191	96	364	775	0.3	0.4	138	10	0.4	0.6	1585
Britton	288	8.0	69	22	3	351	1144	0.3	0	886	350	7.0	0	2563
Britton	276	8.2	72	20	4	337	1148	2.0	0	879	328	7.3	1.5	2556
Britton	288	8.1	71	21	4	351	1141	1.8	0	879	324	7.1	0	2550
Brookings	322	7.5	775	196	64	393	460	7.0	1.0	32	7.0	0.3	0	1079
Brookings	318	7.5	763	201	59	388	448	6.5	1.1	25	7.0	0.3	0.1	1044
Bryant	400	8.1	63	8	8	488	1228	6.0	0.2	1043	442	4.6	0	3004
Bryant	400	8.1	53	14	4	488	1226	0.6	0.1	1004	421	4.8	0	2943

NOTE: Quantities expressed in parts per million, except pH.

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JOB NO._____

TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Canistota	240	7.1	880	224	64	354	1133	1.1	1.4	307	12	0.8	2.5	2057
Canistota	320	7.8	665	178	50	390	506	2.4	0.4	104	9	0.5	0.4	1112
Canova	298	7.7	784	212	60	364	876	3.2	0.2	220	24	0.8	0.6	1659
Canova	296	7.9	702	188	56	361	906	1.1	0.1	291	24	1.1	1.5	1711
Canton	262	7.4	1014	238	102	320	826	0	1.1	69	8	0.5	0.3	1603
Carthage	154	7.3	132	36	10	188	1212	0.5	0	745	245	3.0	4.0	2173
Cavour	272	8.0	80	25	4	332	665	0	0	554	223	1.0	0	1629
Chancellor	454	7.1	1766	449	156	554	1641	1.9	1.7	205	22	1.5	1.2	3127
Claremont	238	7.7	47	18	0	290	1188	0.8	0	861	322	4.8	1.5	2560
Clark	364	7.5	680	167	64	478	840	0.8	0.5	72	56	0.2	0.6	1025
Clark	368	7.4	1020	256	92	488	678	0.7	0.6	80	62	0.4	0.8	1619
Clear Lake	232	7.6	1162	382	51	283	198	0	0	117	671	0.1	1.5	2521
Colman	347	7.4	1021	206	116	423	949	16.0	1.0	179	14	0.5	0	1881
Colman	404	7.5	1137	236	132	493	1074	1.4	1.1	192	11	0.6	1.0	2127
Colton	322	7.4	742	165	80	393	379	0	0.6	57	77	0.5	2.2	1087
Conde	340	8.0	40	8	5	415	1054	0.2	0	842	280	4.2	3.0	2343
Conde	334	7.8	39	10	3	420	1032	0.7	0	842	298	4.2	2.5	2339
Corsica	370	7.8	139	38	11	451	569	0.6	0	438	60	2.2	0	1284
Corsica	360	8.0	141	38	11	439	571	0.8	0	423	60	2.1	0	1304
Cresbard	578	8.2	112	28	10	705	360	0.2	0	782	578	2.3	2.5	2203
Cresbard	556	8.3	82	16	10	703	364	0	0	782	589	2.3	0	2171
Crooks	292	7.5	1683	437	140	356	1444	8.0	1.6	65	8	0.9	0.4	2712
Delmont	382	7.8	66	18	5	466	601	0.3	0	535	135	1.9	0.6	1968
Delmont	384	7.9	62	18	4	469	618	0	0	543	127	1.9	1.5	1569
Doland	286	8.1	30	10	1	349	1003	0.2	0	755	226	3.4	0	2149
Doland	318	7.9	39	11	2	388	904	0.5	0	837	404	3.2	0	2316
Draper	1128	7.9	24	7	1	1376	3	0.7	0	791	433	2.7	0	1973
Dupree	666	8.6	34	9	2	813	172	0.9	0	417	60	0.2	0	1062
Eagle Butte	144	7.2	1353	373	102	176	1281	1.4	0	126	71	4.4	0	2263
Eden	334	7.4	744	199	59	408	521	3.0	0.4	63	5	0.8	0	1156
Edgemont	196	7.6	685	126	36	239	359	0.6	0	234	268	1.2	0	1218
Edgemont	214	7.2	450	127	32	261	296	0	0	214	255	1.2	0	1151
Edgemont	220	8.0	51	17	2	268	1470	0.8	0	795	23	0.7	0	2404
Elk Point	166	7.9	733	222	43	203	724	1.7	0	137	53	2.4	0	1355
Elk Point	168	6.8	755	236	39	205	720	1.4	0	113	53	2.3	0	1355
Emery	400	7.0	1821	465	160	488	1505	0.1	1.5	75	19	0.8	2.0	2913
Esmond	272	7.8	35	10	2	332	1130	0.7	0	770	167	4.0	2.0	2195
Ethan	152	7.3	1306	386	83	185	1252	0.9	0	180	145	2.2	1.0	2497
Eureka	170	7.6	1299	344	106	207	1319	1.8	0	174	66	3.6	0	2462
Eureka	170	8.2	56	16	4	207	1324	0.1	0	745	78	3.6	0.5	2238
Faulkton	506	8.1	84	22	7	617	541	0.2	0	714	378	2.8	0	2007
Faulkton	594	8.4	83	12	13	725	228	0.6	0	1487	1725	2.1	0	4790

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TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Ferney	278	7.7	39	11	3	339	1111	0.6	0	758	173	4.0	0	2228
Flandreau	344	6.8	1098	298	86	408	740	0	0	64	39	0.4	16.0	1640
Forestburg	142	7.5	605	164	46	173	1028	2.0	0	335	77	2.4	0	2173
Frankfort	242	8.0	125	35	9	295	1017	0.3	0	677	206	2.3	0	2073
Frankfort	254	8.0	92	26	6	310	971	1.1	0	697	217	2.3	0	2066
Frankfort	246	8.1	99	29	6	300	1024	0.5	0	700	203	2.2	0	2136
Freeman	380	7.2	915	252	68	464	974	3.6	0.2	256	11	0.7	2.0	1925
Freeman	376	7.2	1007	264	84	459	1050	2.8	0	235	14	0.7	0	2083
Fruitdale	210	7.5	723	203	52	256	560	0.7	0	30	10	0.4	0	1114
Fort Pierre	292	7.6	388	91	37	356	615	0.7	2.4	273	32	0.6	0	1247
Fort Pierre	472	7.5	637	145	65	576	1548	2.0	2.8	734	100	0.7	2.5	2998
Gayville	360	7.5	716	193	55	439	387	0.8	2.4	35	23	0.5	1.0	1036
Geddes	190	7.7	653	187	44	232	943	2.9	0	424	256	1.5	0	2050
Geddes	180	7.5	584	159	44	220	935	3.1	0	412	215	1.4	0	1984
Gettysburg	604	8.3	38	10	3	737	354	0.1	0	774	510	2.5	1.5	2165
Gettysburg	602	8.0	48	10	4	734	528	2.2	0	728	335	2.5	0	2083
Greenway	402	7.3	646	163	58	490	232	0	0	63	63	0.2	15.0	1007
Grenville	351	7.3	902	252	66	428	586	0	0	36	8	0.4	4.5	1285
Grotan (1 of 4)	144	7.7	176	51	11	176	1216	0.9	0	673	135	2.5	1.0	2192
Harrisburg	594	7.2	1706	433	151	725	1382	1.8	0.2	163	11	0.4	0	2783
Hartford (1 of 2)	350	7.4	717	185	62	427	433	0.1	0.5	39	4	0.3	0	1038
Hecla	308	8.2	67	23	2	356	1088	1.2	0	823	282	4.8	0	2454
Henry	358	8.2	406	95	40	437	922	0.9	0	478	75	0.4	4.0	1875
Heried	430	7.6	510	83	73	525	366	1.1	1.1	160	37	0.3	0	1020
Hill City	206	7.1	344	97	25	251	40	0	0.1	224	408	0.3	0	1081
Hitchcock (1 of 2)	136	7.6	1203	346	82	166	1287	1.6	0	207	96	2.8	0	2289
Hosmer	452	8.2	132	34	11	551	229	0.7	0.2	367	157	0.3	1.0	1137
Howard (1 of 3)	331	7.5	618	180	40	404	1042	0.5	1.0	395	21	0.7	0	2007
Humboldt	334	7.3	912	220	87	408	656	0.2	1.7	45	7	0.5	0	1342
Hurley (1 of 4)	282	7.3	896	213	88	344	643	0.1	0	45	13	0.5	3.5	1379
Huron	426	8.1	574	120	67	520	487	0.2	0	218	90	0.5	0	1318
Ipswich (1 of 2)	126	7.6	1226	359	80	154	1264	1.0	0.1	157	53	3.4	0	2261
Irene (1 of 2)	334	7.3	1027	276	80	408	801	4.8	0.1	67	2	0.7	0	1600
Iroquois (1 of 2)	240	7.7	29	7	2	293	1073	0.4	0	724	160	2.5	2.0	2113
Kadoka (1 of 2)	194	7.7	219	68	11	237	1019	1.2	0.3	532	69	1.4	0	1815
Kimball (1 of 2)	148	7.4	1427	417	93	181	1289	1.9	0.4	120	121	3.2	0	2428
Lake Andes	220	8.0	271	74	20	268	479	2.5	0.3	415	305	0.2	1.2	1409
Lake Andes	388	8.3	46	8	5	473	2	2.2	0	772	911	0.6	0	2455
Lake Andes	296	7.6	765	211	56	361	730	0.7	2.8	164	27	0.6	0	1452
Lake Preston (1 of 4)	342	7.8	42	13	2	417	1122	0.3	0	805	180	6.8	2	2328
Lane (1 of 2)	124	7.1	803	226	58	151	1230	0.9	0	332	72	2.6	3.5	2127

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TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Langford	410	8.1	49	15	2	500	1201	0.4	0	895	224	8.0	0	2593
Lemmon	598	8.2	61	18	4	725	861	0.3	0	661	9	1.3	0.7	1964
Lemmon (1 of 3)	770	8.3	14	5	0	939	18	1.1	0	469	155	3.2	0	1180
Lennox (1 of 3)	502	7.1	1416	393	103	612	1153	4.5	1.3	141	11	0.4	0	2300
Leola (1 of 2)	536	7.7	107	27	9	654	433	0.3	0	709	499	2.2	0	2141
Lily	318	8.2	841	230	65	388	738	0.2	0.5	139	17	0.3	0.3	1524
McIntosh (1 of 2)	643	8.3	53	5	10	791	216	0.1	0	399	12	0.8	0	1082
Madison (1 of 2)	350	7.2	1529	415	118	427	1230	1.0	3.0	65	17	0.4	0.1	2313
Madison (1 of 5)	310	7.2	948	256	74	378	675	1.8	1.4	51	33	0.3	0	1545
Mansfield (1 of 2)	222	7.4	46	14	3	271	634	0.6	0	702	467	2.2	2.5	1962
Marion (1 of 3)	302	7.6	530	139	44	368	503	0.8	0.1	164	15	0.6	1.0	1121
Mellette	266	8.4	20	7	0	325	772	1.2	0	682	322	3.0	0	1989
Menno	144	7.3	593	163	44	176	911	1.9	1.4	260	43	0.9	1.5	1614
Menno (1 of 2)	174	7.2	1387	410	88	212	1319	1.8	0.5	171	126	2.8	0.5	2443
Midland	340	7.5	924	267	63	415	1232	0	0	371	67	0.7	0.5	2316
Millbank	346	7.7	640	155	58	422	565	7.5	0.3	187	28	0.4	4.0	1287
Miller (1 of 2)	160	7.4	717	197	54	195	1205	1.3	0	391	90	2.4	0	2124
Mission Hill	144	7.2	1214	368	70	176	1087	2.5	0	133	119	2.8	0	2213
Monroe	352	7.3	649	178	49	429	826	2.0	0.7	275	10	0.5	0	1652
Montrose	332	7.9	728	165	77	405	432	0	0	54	23	0.2	12.0	1078
Morristown (1 of 2)	618	8.4	12	4	0	754	172	0.2	0	402	49	2.6	0.3	1054
Mound City	422	7.5	226	57	20	515	518	0.3	0.8	370	31	0.5	0	1310
Mt. Vernon (1 of 3)	330	7.5	185	52	13	403	740	0.7	0	534	139	1.4	0.9	1723
New Effington	348	7.9	666	171	57	425	469	2.8	0.3	96	17	0.3	0.6	1139
Newell	72	7.5	726	207	51	88	767	0	0	64	8	0.9	0	1259
Newell	70	7.2	934	259	70	85	935	0	0	80	14	1.0	0	1581
New Underwood	376	7.3	488	123	44	459	537	0	0	218	16	0.7	0	1213
Northville	436	8.1	18	5	1	532	585	0.1	0	750	408	3.4	2	2041
Oelrichs	350	7.5	740	155	86	427	1098	0	0	390	34	0.5	0	2174
Oldham	488	8.3	37	7	4	595	997	1.8	0	859	242	8.5	0	2448
Onida	178	7.1	373	96	32	217	947	0.4	0	526	231	2.2	0	2019
Onida	160	7.1	1494	422	106	195	1309	1.5	0	65	75	3.6	0	2496
Orient	376	8.0	97	24	9	469	538	0.7	0	651	340	2.9	2	1801
Parker	310	7.3	564	150	46	378	436	1.1	0.2	103	21	1.0	0	1099
Parker	334	7.3	751	209	55	408	766	1.2	0.1	206	13	1.1	2	1565
Parkston (1 of 2)	260	7.7	537	148	39	317	794	0	2.4	326	75	0.7	0	1589
Peever	522	8.3	423	83	52	637	763	1.8	0	478	66	0.4	7	1854
Pierpont	380	8.1	44	13	2	464	1097	1.1	0	834	227	5.6	0	2421
Pierpont	318	7.5	663	165	59	388	575	1.8	1.7	166	66	0.4	0.1	1309
Plankinton (1 of 2)	436	7.5	92	29	5	532	817	0.2	0	608	63	1.6	2.0	1822
Platte (1 of 3)	438	7.7	88	27	5	534	246	0	0	686	594	2.8	2.5	1910

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TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Pollock	750	7.8	321	73	33	915	205	2.8	0	381	109	0.2	0	1314
Presho (1 of 2)	134	8.0	576	164	40	164	737	1.0	0	286	168	2.8	1.5	1599
Pukwana (1 of 2)	118	7.7	1409	407	89	144	1268	14.0	2.0	126	118	3.0	0.3	2518
Quin	1000	8.1	61	14	4	1220	0	5.2	0	1443	1535	0.6	0.0	3685
Ramona	404	8.3	168	46	13	493	877	1.3	0	606	93	1.9	3.0	1875
Ravinia	230	7.5	488	135	35	281	984	1.8	1.5	475	166	0.5	2.5	2050
Raymond	400	8.0	28	8	2	488	984	0.2	0	802	220	5.6	1.5	2274
Redfield (1 of 2)	236	7.8	166	45	13	290	1103	1.1	0	698	191	2.7	0	2161
Reliance	158	7.4	1218	359	77	193	1196	2.1	0.2	154	104	3.0	0	2149
Rockham (1 of 3)	456	8.1	28	7	2	556	583	1.0	0.2	695	320	3.0	0	1939
Roscoe	764	8.2	45	9	5	932	462	0.5	0.1	843	450	2.8	0	2356
Roslyn	386	7.9	396	84	45	471	377	0.1	0.1	224	63	0.4	1.5	1112
Roswell	208	7.6	524	144	39	254	1136	1.1	0	478	156	2.9	0	2174
Salem (1 of 3)	392	7.4	640	172	51	478	782	0.2	0.7	281	19	0.7	0	1617
Scotland (1 of 2)	390	7.5	1294	348	102	476	1160	2.4	0	162	45	0.8	0	2274
Selby (1 of 3)	410	7.8	771	189	71	500	756	1.1	2.8	221	24	0.4	1.5	1628
Seneca (1 of 2)	140	7.7	122	37	7	171	442	0.2	0.7	388	226	0.6	0.9	1221
Sisseton	280	7.6	728	187	64	342	497	0.2	0	40	4	0.4	1.5	1079
Sisseton	294	7.8	747	190	66	359	517	0.5	0	40	4	0.5	1.5	1150
Spencer	288	7.4	727	200	54	351	799	0.9	2.0	209	50	0.7	0	1566
Springfield (1 of 2)	118	7.1	1262	378	69	144	1128	18.0	0.4	113	142	3.0	0	2323
Stickney (1 of 2)	302	7.3	290	79	22	368	813	0.9	0	401	17	1.2	0	1555
St. Lawrence	486	7.9	318	97	18	593	623	0.2	0.7	437	80	0.5	0	1556
Strandburg	256	7.4	806	228	56	312	645	2.6	0.8	75	5	0.4	0.4	1328
Tabor	218	7.5	406	111	30	266	576	3.5	0	343	235	1.3	2.0	1544
Tripp (1 of 2)	432	7.7	78	22	6	527	324	0.1	0	497	248	1.4	0	1391
Tulare	132	8.0	418	117	30	161	1179	1.2	0	542	132	2.0	0	2135
Twin Brooks	297	8.0	645	176	49	362	495	1.6	0	88	4	0.4	3	1080
Tyndall	146	7.3	1350	413	76	178	1180	3.0	0.2	151	151	3.0	0	1529
Utica	136	7.2	1221	370	71	166	1107	3.2	0	94	111	3.0	0	2040
Veblen (1 of 2)	188	7.8	592	133	63	229	667	0	0	164	37	0.4	0	1343
Vermillion	514	7.4	676	168	61	627	340	2.1	1.4	95	11	0.6	0	1093
Viborg (1 of 2)	184	7.3	528	158	31	225	536	3.2	0	142	78	3.0	0	1181
Vilas	82	7.6	392	94	36	100	1073	4.8	0	484	146	3.2	0	1926
Virgil	148	7.5	938	258	71	180	1225	0.9	0	539	151	2.2	0	2355
Vivian	740	7.5	33	9	2	903	3	0.6	0	748	630	1.7	0	1857
Volin	142	7.2	1228	270	72	173	1112	3.1	0.2	133	116	2.8	0	2258
Wagner (1 of 2)	202	8.3	347	102	20	264	601	0.2	1.6	425	250	0.6	0.8	1559
Wakonda (1 of 2)	348	6.9	965	253	78	407	760	5.0	0.2	65	11	0.7	0	1566
Webster (1 of 4)	304	7.4	801	189	79	371	750	1.1	0.8	152	12	0.6	0	1566
Wentworth (1 of 2)	318	7.2	981	271	74	388	1446	0.7	0	412	29	1.3	3	2577

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TOWN	Alk.	pH	T.H.	Ca.	Mg.	HCO_3	SO_4	Fe.	Mn.	K&Na	Cl.	F	NO_3	T.S.
Wessington	376	7.6	1020	206	123	459	787	0.1	0	162	110	0.5	12.0	1847
Wessington	142	7.2	878	251	61	173	1162	0.6	0	319	154	2.8	2.0	2196
White Lake	152	7.3	1137	328	75	185	1240	3.5	0.2	222	89	2.7	2.0	2212
Wilmot	410	7.6	784	177	82	500	880	3.2	0	305	65	0.4	0.7	1881
Winfred	396	7.8	1212	318	100	483	1353	2.2	1.9	291	11	0.5	4.0	2552
Wolsey (1 of 2)	166	7.7	471	135	32	203	1136	1.3	0	511	152	2.2	0	2113
Woonsocket (1 of 2)	558	8.0	66	19	4	717	372	0.1	0	467	96	0.7	0	1375
Yale	226	7.6	55	14	4	276	1143	0.6	0	740	135	2.5	2.5	2159

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SUBJECT TEXAS -- Chemical Analyses Reports of Water Supplied by Public Water Systems, Bureau of Sanitary Engineering, Texas State Department of Health, Austin, Texas

JOB NO ____

TOWN	Total Solids	pH	Alk.	SiO_2	T.H.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Agua Dulce	1539	8.5	265	22	134	22	13	525	.28	*	226	550	0.4	**	Well
Alice (1 of 9)	1088	7.4	280	19	153	33	17	367	.08	*	257	280	1.0	8.0	Well
Allen	1177	8.5	520	19	40	11	3	411	.24	*	229	124	1.6	2.7	Dist.Sys.
Anna	3654	7.8	605	40	274	52	35	1224	1.20	*	796	1065	2.3	**	Dist.Sys.
Anson	2293	7.4	135	46	1006	272	79	271	0.12	*	1151	174	0.6	18.0	Well
Anson	3484	7.4	210	35	1851	592	91	277	0.15	*	1588	391	0.8	49.0	Well
Anton	1085	7.5	260	60	631	149	63	100	0.10	*	363	149	1.4	2.7	Well
Acquilla	2215	---	415	50	348	37	62	620	0.30	*	1116	85	6.5	**	Dist.Sys.
Arlington	1355	8.4	410	79	28	3	5	426	2.20	*	437	64	1.6	**	Well
Austin	1660	7.5	415	19	263	49	34	469	0.10	*	646	138	6.5	**	Well
Arp	1080	8.4	580	16	62	10	9	407	0.18	*	25	241	0.7	**	Well
Asperment	2662	7.6	305	305	1051	327	39	338	7.00	*	705	486	0.1	51.0	Well
Aspermont	1902	7.6	60	18	1226	417	45	87	.63	*	1200	76	0.2	**	Lake
Bangs	1101	7.5	433	32	636	108	89	167	.08	*	171	263	1.3	22.0	Dist.Sys.
Barstow	1618	7.6	145	44	906	233	79	118	.80	*	780	142	1.2	9.0	Well
Bartlet	1690	8.2	395	30	723	270	12	272	1.80	*	470	305	7.3	2.2	Well
Bedias	1295	7.2	180	48	290	80	22	319	0.78	*	339	320	0.2	3.1	Well
Beeville (1 of 6)	1340	8.3	495	20	43	14	2	537	0.10	*	15	497	1.1	**	Well
Belton (1 of 2)	1376	7.8	370	15	116	30	10	434	0.18	*	258	298	2.2	**	Well
Benavides	1230	8.0	290	18	161	38	16	366	0.12	*	214	316	0.8	27.0	Well
Benjamin	2240	8.0	225	26	1541	476	86	52	0.22	*	1346	21	0.6	**	Spring
Big Lake (1 of 4)	2180	7.5	225	23	929	179	118	317	0.35	*	936	298	3.0	**	Well
Big Spring	1209	8.0	200	51	432	76	59	213	0.12	*	347	231	2.0	12.0	Well
Big Spring	1742	8.2	220	55	620	110	84	325	0.10	*	616	323	2.2	11.0	Well
Bishop (1 of 4)	1061	8.2	260	18	87	20	9	353	0.56	*	191	280	0.4	4.0	Well
Boyd	2310	7.5	235	26	183	50	14	820	0.20	*	123	1136	0.1	**	Well
Boyd	1506	6.9	310	15	265	55	31	473	0.25	*	222	533	0.4	**	Well
Brownfield	1060	7.6	225	67	630	96	95	92	1.20	*	263	231	3.3	8.0	Well
Brownsville (1 of 2)	1980	8.0	475	44	243	46	31	633	0.30	*	556	394	1.4	**	Well
Carrollton	2140	8.0	660	19	61	16	5	753	0.80	*	392	447	3.2	**	Well
Catarina	1433	7.6	205	25	161	25	24	496	0.13	*	301	511	0.5	**	Dist.Sys.
Childress	1885	7.4	50	27	1225	402	54	44	0.56	*	1187	25	0.5	**	Lake
Childress	4190	7.7	195	100	2292	586	202	310	4.20	*	2144	283	0.7	3.3	Well
Chilton	2060	7.6	350	34	290	73	26	688	1.84	*	976	156	3.6	**	Well
Cibola (1 of 2)	2868	7.3	235	38	1317	284	148	466	6.40	*	858	852	2.6	**	Well
Clarkville	1110	8.5	440	31	28	3	5	411	3.80	*	141	238	0.5	**	Well
Clyde	1085	7.7	330	32	504	144	35	164	0.40	*	200	213	1.3	27.0	Well
Coahoma	2015	6.9	195	93	1288	320	119	210	0.30	*	491	724	1.0	22.0	Well

NOTE: Quantities expressed in parts per million, except pH.

* Less than 0.05 ppm ** Less than 0.40 ppm

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JOB NO._____

TOWN	Total Solids	pH	Alk.	SiO_2	T.H.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Combes	1636	7.6	350	46	371	104	27	446	0.08	*	432	383	1.6	1.8	Well
Copperas	3055	7.3	435	40	796	174	88	783	2.10	0.40	626	1001	2.4	**	Well
Copperas	2281	8.2	350	60	160	42	13	765	0.80	*	623	586	3.0	**	Well
Crandall	3480	8.2	1000	68	51	7	8	1291	0.25	*	341	1065	2.2	**	Well
Crane	1656	7.4	300	23	512	88	71	354	0.58	0.10	578	270	0.6	**	Well
Cuero	1058	7.7	475	24	89	24	7	411	0.12	*	40	330	0.5	**	Well
Dallas	1578	8.0	465	19	106	26	10	515	0.40	*	563	124	2.0	**	Well
Devine	1040	6.3	215	39	548	165	33	118	0.16	0.30	221	256	0.6	**	Well
Diboll	1265	8.6	820	36	53	8	8	498	0.80	*	14	213	1.6	**	Well
Donna	1743	8.0	145	38	540	129	53	373	1.90	*	418	347	0.7	**	River
Donna	1990	8.0	215	80	350	104	22	549	1.60	*	576	518	0.7	**	Well
Duncanville	1062	8.5	480	76	46	15	2	351	3.60	*	225	46	2.0	**	Well
Eastland	1710	7.9	435	30	859	285	36	244	0.40	*	170	543	0.3	13.0	Well
Eden	1105	8.1	365	26	38	10	3	415	0.11	*	29	387	2.2	**	Well
Edinburg	2342	8.0	320	36	482	119	45	627	0.08	*	472	753	1.5	**	Well
El Paso	1320	9.1	70	32	212	42	26	373	0.16	*	503	305	0.8	**	River
Ennis (1 of 5)	2228	8.2	825	25	44	11	4	773	0.18	*	505	266	2.4	**	Well
Falls City (1 of 4)	3175	8.2	240	45	43	12	3	1118	0.40	*	1106	767	0.4	**	Well
Ferris	1473	8.4	630	10	294	50	41	415	0.20	*	345	146	3.0	**	Well
Forney	2566	7.0	900	40	151	24	22	907	0.40	*	438	543	2.8	0.4	Dist.Sys.
Forney	2640	8.2	895	23	177	28	26	897	0.70	*	448	543	1.8	**	Well
Forreston	1770	8.4	605	29	70	10	11	644	0.30	*	586	181	3.6	**	Well
Freer	1000	8.0	275	18	211	45	24	298	0.35	*	41	383	0.7	**	Well
Galveston	1775	7.9	285	40	280	61	31	568	0.25	*	27	852	0.4	**	Well
Garland	1202	8.4	420	28	75	15	9	409	0.20	*	378	107	0.2	**	Well
Gatesville	1200	8.1	360	14	118	39	5	403	0.20	*	206	298	1.9	**	Dist.Sys.
George West	1310	7.8	300	45	270	72	22	371	0.28	*	353	291	1.2	**	Well
Giddings	1280	8.0	265	--	53	13	5	339	5.00	*	332	178	2.4	**	Well
Gladewater	1265	8.2	315	18	110	24	12	438	0.12	*	35	504	0.2	4.0	Well
Gonzales	1142	8.2	245	22	450	121	36	220	1.00	*	79	426	0.4	2.7	Well
Goree	1412	7.2	345	34	511	109	58	285	0.16	*	373	256	1.5	27.0	Well
Gorman	1971	6.9	365	33	1159	410	33	184	0.28	*	286	621	---	**	Well
Grand Falls	1550	---	205	40	439	118	35	350	0.50	*	360	440	2.0	**	Well
Granger	1780	8.0	370	28	212	42	26	568	3.40	*	476	412	3.0	**	Well
Grapevine	1130	8.4	510	16	122	42	4	371	0.22	*	209	142	2.0	**	Well
Greveton	1000	8.2	320	41	68	19	5	324	0.12	*	267	124	0.4	0.4	Dist.Sys.
Harlingen	1475	7.9	230	74	459	100	51	301	2.80	*	416	320	0.7	**	Well
Haskell	1308	7.8	270	26	604	130	68	254	0.16	*	433	309	1.2	2.4	Dist.Sys.
Hebbronville	1198	8.5	370	22	45	13	3	434	0.90	*	254	252	2.5	**	Well

* Less than 0.05 ppm ** Less than 0.40 ppm

SHEPPARD T. POWELL AND ASSOCIATES
CONSULTING ENGINEERS
BALTIMORE, MD.

SHEET_____ OF_____

_____ 19____

SUBJECT TEXAS -- Chemical Analyses Reports of Water Supplied by Public Water Systems, Bureau of Sanitary Engineering, Texas State Department of Health, Austin, Texas

JOB NO._____

T O W N	Total Solids	pH	Alk.	SiO_2	T.H.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Hemphill	1236	8.6	870	16	31	9	2	508	0.60	*	5	185	2.6	**	Well
Hidalgo	1420	7.7	355	49	810	224	61	132	3.40	0.60	418	217	0.4	**	Well
Holland	2413	8.0	345	40	363	78	41	636	0.70	*	985	344	4.0	4.40	Well
Ingleside	2152	7.7	295	33	537	90	76	564	6.00	0.20	64	994	1.0	**	Well
Iola	1122	7.8	195	54	182	38	21	348	2.80	*	223	362	0.1	**	Well
Irene	2315	8.3	630	33	48	14	3	801	0.55	*	499	454	1.8	2.20	Dist.Sys.
Irving	1612	8.3	500	29	49	13	4	539	0.90	*	523	156	1.8	**	Well
Italy	1592	8.3	585	17	33	10	2	564	0.12	*	494	114	4.8	**	Well
Joaquin	1210	8.3	650	15	50	10	6	468	0.20	*	10	288	2.0	**	Well
Karnes City	1293	8.8	275	75	100	35	3	421	0.50	*	135	426	2.0	**	Well
Kenedy	2100	8.5	370	91	160	56	5	684	0.60	*	218	738	1.2	4.0	Well
Kilgore	1842	8.3	505	41	55	18	6	672	0.45	*	23	699	0.5	**	Well
Kingsville	1282	7.7	195	17	182	53	12	387	0.63	*	322	334	0.5	27.0	Well
Knox City	1160	7.5	300	38	506	58	88	187	0.28	*	263	231	1.0	18.0	Well
Ladonia	3710	7.9	670	23	303	34	53	1318	4.00	*	189	1633	2.2	**	Well
La Feria	1980	7.6	380	79	556	127	58	491	1.20	*	574	458	1.0	**	Well
Lake Jackson	1001	8.0	---	4	213	36	31	240	1.60	*	46	264	0.5	---	Well
Lampasas	1078	7.7	290	33	418	105	38	213	0.34	0.1	29	398	0.1	**	Creek
Lancaster	1402	8.3	445	16	30	7	3	497	0.22	*	484	114	1.4	**	Well
Lefors	1715	6.8	200	30	591	194	26	358	0.15	*	47	795	0.2	2.70	Well
Lewisville	1270	8.1	325	23	52	14	4	438	0.18	*	257	291	1.2	**	Well
Lone Oak	1735	7.8	765	17	108	20	14	661	0.15	*	22	536	4.0	**	Well
Lubbock	1035	8.0	320	59	530	110	62	132	0.20	*	328	110	3.0	4.0	Boost.Sta.
Luling	1220	8.6	535	12	52	11	6	430	.06	*	183	185	0.1	**	Well
Malone	3560	7.3	205	34	753	180	74	851	7.0	*	2200	78	1.8	**	Dist.Sys.
Manor	1888	---	315	29	376	98	32	493	2.80	*	724	270	3.9	**	Well
Mathis	1122	7.5	260	25	263	66	24	310	0.88	*	89	415	0.6	**	Well
McAllen	1647	8.2	110	22	549	136	51	344	0.04	*	377	564	0.8	1.3	River
McCamey	2023	7.3	240	39	1044	224	118	203	0.20	*	1013	136	2.4	40	Well
McKinney	1328	7.9	325	25	87	23	7	456	0.04	*	464	192	0.6	**	Well
Melissa	3010	8.1	685	23	269	50	35	1060	1.50	*	101	1264	2.2	2.7	Well
Memphis	1086	8.4	308	35	750	154	89	57	0.15	*	380	170	1.4	**	Well
Mercedes	1250	8.2	300	31	243	56	25	347	0.09	*	347	238	1.6	**	Well
Mertens	1620	8.0	535	28	69	11	10	564	0.12	*	493	174	3.2	2.2	Dist.Sys.
Mesquite	2134	8.0	755	39	32	11	1	784	0.35	*	328	454	3.6	**	Well
Midland	2208	7.4	225	78	1036	206	127	298	0.44	*	771	451	3.2	25.0	Dist.Sys.
Miles	1560	7.0	250	30	831	200	82	162	0.40	*	603	213	1.4	8.0	Well
Mineral Wells	1728	8.0	100	56	482	147	28	368	2.00	*	322	600	0.4	**	Well
Mission	2312	7.9	230	71	410	90	45	659	0.30	*	341	891	0.8	**	Well
Mont Belvieu	1281	7.9	---	21	42	7	6	415	0.15	---	119	383	1.1	---	Well

* Less than 0.05 ppm ** Less than 0.40 ppm

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SHEET____ OF____

_____ 19____

SUBJECT TEXAS -- Chemical Analyses Reports of Water Supplied by Public Water Systems, Bureau of Sanitary Engineering, Texas State Department of Health, Austin, Texas

JOB NO.____

TOWN	Total Solids	pH	Alk.	SiO_2	T.H.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Munday	1772	7.9	325	41	880	160	117	236	0.48	*	438	419	2.0	27.0	Well
Natalia	2130	7.1	403	136	824	218	68	360	1.50	*	394	568	1.2	**	Well
Nocona	1643	8.0	463	12	76	17	8	630	0.90	*	78	639	2.0	**	Well
O'Donnell	1000	7.4	295	53	480	87	64	148	0.04	*	229	181	5.0	18.0	Reservoir
Orange Grove	1107	7.5	318	27	271	64	27	299	0.07	*	118	337	0.8	7.1	Well
Paducah	5440	7.5	215	78	2362	614	202	745	0.10	0.6	1985	1207	0.6	**	Well
Palmer	2065	7.9	755	60	18	4	2	776	0.23	*	318	440	3.2	4.4	Dist.Sys.
Pampa	1122	7.9	190	25	329	79	32	261	0.16	*	67	53	1.0	3.5	Dist.Sys.
Pecos City	4190	7.5	120	20	2276	678	130	365	0.20	*	1680	717	1.6	83.0	Well
Pharr	1613	8.1	175	28	539	131	49	345	0.12	*	357	518	0.7	**	Well
Plains	1508	7.8	200	63	750	126	106	165	0.20	*	729	103	4.0	7.0	Dist.Sys.
Plaino	2155	8.0	710	49	33	5	5	767	0.15	*	447	373	2.0	**	Well
Pleasant Grove	2940	8.0	690	26	139	34	13	1101	2.50	*	20	1292	2.6	0.4	Well
Port Aransas	1720	7.8	290	25	489	92	63	438	.35	.2	119	728	0.4	2.2	Well
Port Isabel	1930	7.4	60	45	607	141	62	392	0.32	*	417	685	0.8	**	River
Port Lavaca	1957	7.7	315	20	368	98	30	647	0.20	*	6	1030	1.2	3.5	Well
Prosper	1908	8.4	755	16	51	12	5	690	0.28	*	372	291	2.4	**	Well
Quanah	1020	7.6	255	19	501	128	44	157	0.15	*	246	220	0.3	27.0	Well
Rankin	1642	7.3	258	14	823	150	109	237	1.60	*	828	156	2.0	11.0	Well
Raymondville	2217	8.3	150	35	150	28	20	752	0.10	*	745	611	2.0	**	Well
Red Oak	1244	8.3	475	16	40	6	6	459	0.08	*	407	99	2.0	**	Well
Refugio	1000	8.4	340	16	56	14	5	367	0.20	*	56	323	1.8	**	Well
Richardson	1105	8.4	445	33	47	12	4	47	0.10	*	323	114	2.0	**	Well
Riesel	2668	7.2	180	42	337	102	20	725	1.10	*	1559	78	1.1	**	Well
Rio Grande City	1372	7.6	615	50	681	184	--	228	18.8	0.30	169	273	0.2	**	Well
Rio Hondo	1045	8.0	160	36	405	108	33	175	0.20	0.35	288	231	0.6	**	Well
Rockport	1390	7.4	295	27	508	131	44	284	0.50	0.10	88	525	0.1	**	Well
Rockwall	3835	8.0	875	23	102	16	15	1530	0.40	*	76	1750	2.0	**	Well
Rogers	1088	8.5	420	33	58	20	2	386	0.60	*	291	117	2.8	**	Well
Rosebud	5505	6.2	165	96	909	272	56	1332	0.35	*	3206	217	2.0	**	Well
Rotan	2005	7.4	255	41	1266	380	53	106	0.70	*	859	213	1.1	0.59	Well
Rowena	1483	7.0	235	49	963	218	102	96	2.30	*	423	341	1.1	19.0	Well
Roxton	1086	7.1	378	22	---	218	17	42	0.08	0.12	42	154	0.4	75.0	Well
San Benito	2027	8.0	355	40	368	80	41	574	0.30	*	702	376	1.2	**	Well
San Juan	1454	7.6	245	32	435	90	39	326	0.18	*	349	380	0.7	**	Well
Seagoville	2500	8.0	625	33	148	23	22	842	0.28	*	846	337	4.0	**	Reservoir
Sinton	2630	8.0	350	24	58	17	4	1003	0.50	*	14	1331	1.8	**	Well
Somerville	1777	7.6	405	48	250	77	14	553	0.73	*	227	575	0.4	**	Well
Spur	2300	7.4	275	26	891	204	93	400	0.75	0.5	847	422	2.4	10.0	Well
Sweeny	1440	7.1	210	20	288	66	30	423	0.26	0.15	44	678	0.7	**	Well

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SHEET____ OF ____

_____ 19____

SUBJECT TEXAS -- Chemical Analyses Reports of Water Supplied by Public Water Systems, Bureau of Sanitary Engineering, Texas State Department of Health, Austin, Texas

JOB NO.____

TOWN	Total Solids	pH	Alk.	SiO_2	T.H.	Ca	Mg	Na	Fe	Mn	SO_4	Cl	F	NO_3	Source
Taft	3240	7.5	293	560	712	216	42	667	10.0	0.20	124	235	1.0	**	Well
Talco	1080	8.7	435	18	54	18	7	407	0.12	*	18	341	0.2	**	Dist.Sys.
Taylor	1294	7.1	343	27	80	22	6	436	0.96	*	330	243	2.1	**	Well
Temple	1190	8.3	365	16	110	28	11	424	0.80	*	261	280	1.1	**	Well
Texas City	1000	7.9	285	23	61	16	5	348	3.00	*	6	373	0.6	**	Well
Thorndale	1050	7.4	345	28	483	154	24	198	0.04	*	249	131	0.6	155	Well
Tivoli	1300	7.4	360	22	71	15	8	465	1.00	*	38	483	2.4	**	Well
Tornillo	1550	7.5	165	32	492	136	37	351	0.22	0.3	239	596	0.9	**	Well
Trent	2475	7.9	450	43	458	162	13	649	0.20	*	841	351	2.8	35	Dist.Sys.
Van Alstyne	3279	8.0	485	87	78	23	5	1121	1.25	*	1321	465	1.8	**	Well
Velasco	1400	7.9	545	16	187	42	20	487	0.64	*	14	486	0.6	**	Well
Vickery	1618	8.1	585	24	52	11	6	589	0.30	*	420	181	3.0	4.4	Dist.Sys.
Waxahachie	1185	8.3	450	33	21	5	2	423	0.12	*	115	263	1.6	**	Well
Weslaco	2112	7.8	235	67	363	86	36	619	0.90	*	709	522	1.0	**	Well
Westover Hills	1040	8.5	475	19	16	3	2	368	0.09	*	202	92	1.6	2.7	Well
Whitewright	1725	8.2	500	28	102	29	7	589	0.35	*	73	572	1.6	**	Well
Wilmer	3188	7.8	400	55	114	34	7	1047	2.40	*	1711	149	2.6	**	Well
Wink	1750	7.6	125	60	1045	282	83	125	0.40	*	474	490	1.2	9	Well
Woodsboro	1180	7.5	320	26	341	74	38	310	0.08	*	128	398	0.5	**	Well

* Less than 0.05 ppm ** Less than 0.40 ppm

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SUBJECT Miscellaneous Brackish Rivers - Maximum Solids
From: "Quality of Surface Waters of the United States 1949", U.S.G.S.

JOB NO ___

NAME OF RIVER	Total Solids	pH	HCO_3	SiO_2	T.H.	Ca	Mg	Na	SO_4	Cl	NEAR
Arkansas River	3320	7.9	332	15	1640	384	166	426	2050	111	Fort Lyon, Colo.
Arkansas River	3330	7.5	418	17	1550	344	169	476	2000	113	Caddoa, Colo.
Arkansas River	3230	---	90	--	592	153	51	1000	259	1720	Tulsa, Okla.
Canadian River	1800	8.0	179	11	979	118	118	195	1140	48	Sanchez, N. M.
Canadian River	1380	---	243	14	384	78	46	350	381	388	Tascosa, Tex.
Canadian River	1390	---	295	--	628	168	51	265	520	300	Bridgeport, Okla.
Canadian River	6150	---	138	--	1360	372	105	1850	74	3680	Whitefield, Okla.
Deep Fork River	2730	---	198	--	624	158	56	817	50	1550	Dewor, Okla.
Cimarron River	2810	---	256	-	1810	388	204	189	1820	81	Springer, N. M.
Little Beaver Creek	1100	---	265	--	665	166	61	132	328	278	Duncan, Okla.
Washita River	1240	---	211	--	672	174	58	166	482	252	Tabler, Okla.
Rush Creek	1600	---	161	--	588	92	87	384	149	790	Purdy, Okla.
Sulphur River	5240	---	103	11	557	149	45	1760	668	2560	Darden, Tex.
Prairie Dog Fork, Red River	10,900	7.9	118	26	2220	639	153	3150	1840	5000	Brice, Tex.
Trinity River	1190	---	141	13	204	64	11	359	126	495	Oakwood, Tex.
Trinity River	2260	7.7	133	9	490	76	73	676	191	1170	Cove, Tex.
Trinity River	4170	7.7	148	15	858	100	148	1270	316	2250	Anahuac, Tex.
Brazos River	4570	---	130	8	1970	576	93	856	1630	1330	Aspermont, Tex.
Brazos River	1690	7.8	119	9	578	184	29	377	417	612	Graford, Tex.
Brazos River	1560	---	114	13	542	161	34	345	391	562	Whitney, Tex.
Brazos River	1070	7.5	137	9	366	114	20	198	245	372	Richmond, Tex.
Salt Fork (Brazos)	78,500	---	105	14	5330	1330	490	28,400	2850	45,400	Aspermont, Tex.
Clear Fork (Brazos)	3910	7.8	140	4	1490	370	138	774	1460	1090	Nugent, Tex.
Brazos River	1470	---	138	8	541	159	35	313	372	512	Marlin, Tex.
Colorado River	13,800	7.5	121	8.4	1990	477	195	4450	1500	7100	Colo. City, Tex.
Colorado River	3030	---	146	8	554	148	45	925	372	1460	Robert Lee, Tex.
Morgan Creek	5310	---	159	2.8	1070	238	116	1540	1130	2200	Colo. City, Tex.
Rio Grande	1160	7.7	220	18	506	152	31	180	605	63	San Acacia, N. M.
Rio Grande	1090	7.7	243	20	474	144	28	172	534	66	San Marcial, N. M.
Pecus River	2420	7.9	163	25	1690	556	74	75	1470	135	Puerta de Luna, N. M.
Pecus River	18,300	7.2	136	16	4110	924	438	5160	3590	8790	Acme, N. M.
Pecus River	6460	7.5	173	17	2630	606	271	1220	2360	1900	Artesia, N. M.
Pecus River	7060	7.6	114	10	2430	580	238	1570	2036	2580	Orla, Tex.
Los Olmos Creek	11,500	7.5	106	23	2070	681	89	3550	1070	6080	R. Grande City, Tex.

NOTE: Quantities expressed in parts per million, except pH.

Senator ANDERSON. The next witness will be Mr. Ralph Brody, representing Governor Brown of California.

STATEMENT OF RALPH M. BRODY, SPECIAL COUNSEL TO GOV. EDMUND G. BROWN OF CALIFORNIA

Mr. BRODY. My name is Ralph M. Brody. I am special counsel on water matters to Gov. Edmund G. Brown of the State of California. I am appearing here at the request of Governor Brown in support of S. 3557. Governor Brown expresses his personal regret at not being able to appear personally to support this legislation.

This statement will be brief, but I hope its brevity will not be thought of as a lack of enthusiasm to support this legislation.

Senator ANDERSON. The fact that you have crossed the continent is a good indication of your interest in it.

Mr. BRODY. Thank you.

There is no need for me to recite to this committee the need for the development of new water supplies throughout our land. I might cite as an example, however, that in California alone the demands of our population are increasing faster than we can develop supplies through local, Federal, and now State construction. When our population was at a level of 14½ million people a year or so ago our consumption of water was at 22 million acre-feet. It is estimated that by 1975 our demand will reach between 32 and 35 million acre-feet and under ultimate conditions a demand for our consumption purposes will reach approximately 51 million acre-feet per season.

We are building, with Federal assistance, to meet these needs but the water supplies become more costly. As the older sites are developed we are forced to the newer, more remote and more expensive ones. I might point out at this junction that we are presently submitting to the voters of California in November of this year a bond authorization for their approval in the amount of $1,750 million. This will involve the construction of some 750 miles of aqueduct to transport water to the areas of need, at a cost, of the aqueduct systems themselves, of close to a billion dollars of the total $1,750 million authorization. I mention this in relationship also to the testimony offered earlier by Mr. Shanks of the Prudential Insurance Co.

Senator ANDERSON. It costs money to move this water around, doesn't it?

Mr. BRODY. It certainly does.

While we recognize that no matter what the cost, we must meet the need of people for water. We also recognize that low cost water is necessary to assist and build an agricultural and industrial economy. Water can be as unavailable from an economic as it can be from a physical standpoint. Therefore, we consider it imperative that new methods and sources be explored. Saline water conversion appears to be the next logical step. This is not to deprecate those steps which have already been taken toward progress, but we are to proceed much more rapidly to meet our needs, not only in California but throughout the Nation.

California was gratified by the enactment of the original saline water conversion legislation. Under that program just last week we were informed that a sea water conversion plant will be con-

NOTE: Quantities expressed in parts per million, except pH.

structed at Point Loma in our State. However, S. 3557 provides a much needed expansion of the original program. If we are to be timely, the development and exploration of saline water conversion methods must be pursued on a logical and coordinated basis.

The legislation there under discussion is valuable because it not only provides for accelerated activity by the Federal Government but also encourages local and private action on a cooperative basis with the Federal Government, which many agencies are anxious to undertake, as well as independent action by such agencies. Such coordinated action in our judgment will eliminate a considerable amount of duplicative and wasted time, effort, and expense in study and experimentation. By cooperative effort and the assembly and dissemination of current data the bill would permit a coordination of activity that is presently lacking. I believe that you, Chairman Anderson, succinctly stated the present need as we see it when you stated:

> I favor research but we must all insist that demonstrations of proven conversion processes be pressed to show whether theories and promising techniques can be proved or disproved. Progress has been made toward reducing conversion cost both as to sea water and brackish water. However, we want to be able to explain in simple, understandable terms what has been achieved.

Much progress apparently has been made throughout the United States and, indeed, throughout the world on this subject on theoretical bases. But theory without demonstration of the efficacy, the practicability, and the financial feasibility of that theory does not make for real progress. S. 3557 makes possible much needed expanded demonstration programs.

Of equal importance is the fact that the bill would provide a centralized source of information on this important subject to serve not only the technicians but also the public generally. The urgency for definitive action and answers on saline water conversion is, we believe, being felt throughout the United States and the world. We in California know that it is in our own State. There is a general awareness among our people that studies are being conducted in this field but there is little knowledge of the extent to which such studies may have been pursued. As a matter of fact, we sometimes become concerned that the public generally, upon the basis of meager information, may be becoming convinced that such a method for meeting water needs will develop much sooner than actually is the case. The lack of a centralized source of reliable information on this subject tends to some extent to delay water resource development construction which should be going forward now while conversion methods are being developed and tested. There is a tendency upon the part of some to discourage vitally needed immediate construction because they are misinformed as to the imminence of economically feasible saline water conversion methods.

In our judgment, therefore, S. 3557 currently being considered by your committee merits approval. It provides for much needed research activity, a desirable measure of centralization of activity in the field, assures more extensive saline water demonstration programs, provides for cooperation which will facilitate and expedite the develment of methods, and for the assembly and dissemination of valuable information.

I might state at this juncture that I was interested in a news clipping that I read on the plane coming East. Dr. Joseph Kaplan,

Chairman of the International Geophysical Year, has suggested that there be a water year throughout the Nation and throughout the world. But I was interested because of the international cooperation aspects of S. 3557 and his comments when he was discussing this particular suggestion. The article states that Dr. Kaplan, professor of physics at the University of California at Los Angeles, told an interviewer that he believes the project to direct the attention of all the scientists to the development of water resources is the most important idea for international cooperation that exists today.

We understand that the Bureau of the Budget has raised a question concerning the loan program under title II and has pointed out that the Housing and Home Finance Agency already has the authority to make 40-year loans to qualified smaller municipalities for saline water conversion plants. We respectfully suggest that since the purpose of this legislation is primarily for research activity the function of making loans for saline water conversion plants might more appropriately repose in the agency which has the primary responsibility for the research activity, rather than in a pure lending activity. That concludes my remarks, Mr. Chairman.

We strongly urge that this committee give approval of S. 3557, and I wish to express my thanks and those of Governor Brown to the committee for this opportunity.

Senator ANDERSON. I was particularly interested, Mr. Brody, in what you just said a moment ago, that you have felt that the Office of Saline Water would be in a better position to judge whether a loan should be made than a pure loaning agency. That could be based on the fact that they were familiar with all processes and the general development of the field, and, therefore, might have more knowledge of how valuable this contribution might be.

Mr. BRODY. Yes, sir, Mr. Chairman. In addition to that, I would point out, and I fail to recall which specific section of the bill it is, it provides that in the lending program, provision would also be made for cooperation between the Department of the Interior and the agency to whom the loan is made. I would suggest that this might be facilitated by the loan, itself, being made by that agency.

Senator ANDERSON. Just for the record, California, in order to survey its future water needs, has a program of expenditure. What are the limits of that, running into how many billions of dollars?

Mr. BRODY. Some 14 billions of dollars, Mr. Chairman.

Senator ANDERSON. And, therefore, naturally while they talk about additional burdens of this bill, if the State of California can construct some conversion plants so that it can economically convert sea water into potable water, there are offsetting benefits in the fact that it would not have to spend quite so much money in the overall program.

Mr. BRODY. Most definitely; yes, sir.

Senator ANDERSON. Thank you very much.

Senator Moss?

Senator MOSS. I have no questions, Mr. Chairman.

Senator ANDERSON. Senator Allott?

Senator ALLOTT. No questions, Mr. Chairman.

Senator ANDERSON. Thank you, Mr. Brody. We appreciate your coming. Thank Governor Brown for letting you come.

Now we come to the next witness, who is Dr. Arthur L. Miller, Director of the Office of Saline Water, and such other members as he wishes.

May I say we are happy to welcome you again. We have had many contacts with you when you were in the House, and we are happy to have you here.

STATEMENT OF DR. ARTHUR L. MILLER, DIRECTOR, OFFICE OF SALINE WATER, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY JOHN O'MEARA, STAFF ASSISTANT TO THE DIRECTOR AND INFORMATION OFFICER; DR. W. S. GILLAM, CHIEF, DIVISION OF RESEARCH; JOE STROBEL, CHIEF, DIVISION OF PROCESSES DEVELOPMENT; ALLEN CYWIN, CHIEF, DIVISION OF DEMONSTRATION PLANTS, OFFICE OF SALINE WATER, DEPARTMENT OF THE INTERIOR

Dr. MILLER. Thank you, Mr. Chairman. It is always a pleasure to appear before your committee. I have a statement I would like to present, if I may. When I have completed my statement, if there are any questions, as I hope there will be, I have my technical staff with me to answer some of the engineering questions and other details that might be presented.

Senator ANDERSON. Without objection, that may be done.

Dr. MILLER. It is indeed a pleasure for me to represent the Department of the Interior here today. Secretary Seaton regrets that other commitments make it impossible for him to appear before this committee today. I hardly think it necessary to remind you of the Secretary's intense interest in the saline water conversion program. His leadership and guidance have been a source of encouragement and inspiration to me and the members of my staff to conduct the activities of our office with a sense of urgency commensurate with the rapidly increasing demands for additional supplies of fresh water.

A few weeks ago, in one of the technical magazines that cross my desk, I noticed an article that stated:

> If the Office of Saline Water never produces a drop of fresh water from the ocean, it has more than justified its existence by alerting the American public to the problems faced by this Nation to develop an adequate supply of water for our future needs.

While this may be a negative compliment, we do feel that the office has helped in a substantial way to create an awareness in the public mind that our natural sources of fresh water are a limited commodity.

Our success in this direction is evident from several recent developments: The increasing number of letters received by our Office from responsible citizens in all sections of the country and from many other countries of the world, asking for information or technical assistance. Hardly a week goes by that we are not visited by representatives of several research or industrial organizations expressing their interest in our endeavors and outlining activities within the scope of our program that their firms are undertaking or propose to undertake. We are receiving more and more attention from the press. As a matter of interest—at the present time, at least three major magazines are preparing articles on our programs for publication in the near future

and the Research and Education Committee for a Free World has recently published an excellent fact book on saline water conversion. Oover 200 cities and communities asked to be considered as a site for one of the five saline water conversion demonstration plants authorized by Public Law 85–883. We sold 267 sets of plans and specifications, at $16 per set, for the first of these plants. But most important, 6 Members of the House of Representatives and 35 Senators have introduced or have cosponsored legislation that would expand and enlarge the saline water conversion program.

I would like to express my appreciation, not only to those Members of the Congress who have introduced such legislation, but also to thank the Members of Congress who have written in behalf of their constituents or visited the Office to express their interest and support of our endeavors.

Unquestionably, serious problems exist in many areas of the country and these problems will become more acute as the expanding national and world population require an increasing supply of potable water.

At this point I ask permission to insert in the record some quotations from a few of the hundreds of communications we have received in the Office from prominent people that help point up the problems of the growing water shortage in several areas of the United States.

(The information referred to follows:)

EXCERPTS FROM COMMUNICATIONS RECEIVED IN THE OFFICE OF SALINE WATER, DEPARTMENT OF THE INTERIOR

Vice President Richard Nixon, Washington, D.C., March 15, 1960

"As you know, I am greatly interested in the work of your Office and I think you and your staff deserve the highest commendation for the truly great progress that has been made and will be made in finding an inexpensive process for converting saline and brackish water into use."

Senator J. Allen Frear, Jr., Delaware, March 14, 1960

"My interest in your comments stems from the problem confronting my State of Delaware in not having an available supply of fresh water after the next 20-year period. Several proposals are being contemplated in an effort to combat this future hazard, and the objectives of your Office may well be studied in this connection."

Representative Hamer H. Budge, Idaho, March 10, 1960

"It seems to me that, certainly on a large-scale basis, more progress has been made in the last year on such a matter than in the last century."

Representative Howard W. Smith, Virginia, March 7, 1960

"* * * I am very much interested in this endeavor and have great hopes for it in the future. Therefore, I have kept up very closely with your progress and am happy to observe the progress you have made, which seems to be quite remarkable. I feel sure that in time you will get the process worked out to a point where it is economical."

Representative Wayne N. Aspinall, Colorado, March 4, 1960

"With all five conversion processes now selected and funds available to start construction of these demonstration plants, it appears that we are on the way to obtaining some firm information with respect to feasibility and costs."

Senator Gordon Allott, Colorado, March 1, 1960

"It is my firm belief that the sooner sea water can be converted for consumptive use, the sooner those of us in the interior States can stop spending our time arguing with seacoast States and put our own water to our own needs."

Representative Walt Horan, Washington State, March 1, 1960

"To me, the whole matter of what may come out of the activities of the Office of Saline Water is of tremendous importance to the future. However, I have

thought that the title of the office could be changed so that it would have a broader connotation. Certainly anything that leads to the desalting or purification of water is mighty important to this Nation and world of ours at a time when we are having such a population explosion."

Senator Oren E. Long, Hawaii, February 29, 1960

"The saline water program is of especial interest to Hawaii, and I would be appreciative of any suggestions you may have for the application of your research to the water problems of my State under the techniques which you are now perfecting."

Senator Francis Case, South Dakota, February 29, 1960

"I personally found your review most helpful and I think it is an excellent way of keeping us apprised of developments in this fast-changing field.

"It was particularly interesting to learn that the latest innovations in the electrodialysis process as revealed by the Bureau of Reclamation tests at Denver will be incorporated in the Webster plant."

Gov. Nelson A. Rockefeller, State of New York

"New York State faces a very serious water problem in its Long Island counties outside the city of New York. The great outpouring of population has created a heavy demand for fresh water in Nassau and Suffolk Counties and the forecast is for even greater population growth. Moreover, in Suffolk County our agriculture has come to depend upon irrigation for an increasing rise of its annual production. Ground water supplies are limited and in certain areas the water table has already been seriously lowered."

Gov. Robert B. Meyner, State of New Jersey

"The salt water conversion demonstration plant program of your Department is a matter of deep concern to the State of New Jersey. The bulk of the population increase coming in the New York City metropolitan region will center in northern New Jersey. The region between Trenton and Wilmington is one of the fastest growing industrial areas in the Nation. Many water problem areas already exist in New Jersey. The availability of economically feasible surface water storage sites is already a serious problem. The citizens of New Jersey have just recently approved by public referendum a bond issue totaling $45 million for acquisition and development of surface storage sites.

"The people of New Jersey have become strongly conscious of the need for guaranteed future sources of potable water supply. There is, therefore, a strong public interest within New Jersey in any program, experimental or practical, which gives promise of providing that guarantee."

Dr. J. A. Hockaday, mayor of Port Isabel, Tex.

"The domestic water situation is indeed critical in this area, and unless some source of potable domestic water can be provided to meet its needs, this promising area of south Texas will be stymied in its development."

Mr. King C. Tom, chemical engineer, Branch of Lok Hoi Tong Co., Ltd., Hong Kong, China

"Here I am visiting the Hong Kong colony, and I have found she is facing a serious problem of water shortage.

"In a way, I try to help them to combat communism, because we will have to buy water from Communist China very soon."

Mr. H. Lee Dennison, county executive, Suffolk County, Hauppauge, N.Y.

"At present our water comes entirely from underground supplies, tapped by wells at depths of 40 to 110 feet. Because of their shallowness and proximity to the ocean, these wells, along the coast, are liable to pull in salt water when pumped vigorously. This has happened on several occasions and represents an imposing limitation to the use of ground waters to accommodate the rising demand for water in the county. Further, the widespread use of septic tanks and cesspools has resulted in the contamination of underground water in a number of areas of the county.

"Because of our precarious water position and the complications of explosive population growth, we are anxious to see methods of reclaiming fresh water from salt become commercially successful."

Dr. MILLER. Secretary Seaton has said a number of times in public speeches that water—just plain, ordinary water—may be our No. 1 domestic problem by 1980. "One day, sooner than many people think," he has said, "we shall have to follow a new trail for our water supply, and, at least for certain areas, that trail leads both to huge known supplies of brackish water inland and to the vast inexhaustible oceans of the world." His prediction was recently supported by the statement of Surg. Gen. Leroy E. Burney before the National Convention of the Rivers and Harbors Congress that the Nation's fresh water needs will exceed the natural supply by 85 billion gallons a day within 20 years.

It is my own personal opinion that should a severe drought occur, similar to those we endured in the early thirties, in 1953 or in 1957, that a real emergency would occur in thousands of communities in the United States.

While it may be debated to what extent the Office of Saline Water has contributed to alert the Nation to its impending water problems, on the other side of the ledger, we have, without question, made real and exciting progress through our present research program to develop low-cost conversion processes. It should be pointed out that when the Office of Saline Water was authorized by the Congress in 1952, the best cost figures for converting sea water to fresh ranged upward from $5 per thousand gallons. We are now able to bring before you today models of two 1 million gallons per day distillation plants. The long-tube vertical distillation process will be located at Freeport, Tex., and the multistage flash process will be located at San Diego, Calif.

We opened construction bids for the Freeport plant on May 24, and I am pleased to announce that we have given Chicago Bridge & Iron Co., the successful low bidder, notice to proceed. The contract calls for construction to be completed in 9 months. The process to be utilized in this plant incorporates several newly developed technical innovations resulting from OSW-sponsored research which we confidently expect will permit this plant to produce fresh water from the sea for about $1 per thousand gallons. When this same process is incorporated in plants designed to produce 15 to 20 million gallons of fresh water per day, we will gain economies which will convert water at a much lower price.

We are, therefore, demonstrating a conversion process that is now ready for commercial application capable of producing fresh water from the sea at a price competitive with rates now charged in some U.S. municipalities.

The final answer to low-cost conversion, however, has not yet been found. Indeed, the demonstration plants erected today may be outmoded in a few years. Continued research is necessary to make this possible. It may not be achieved through a spectacular breakthrough, which cannot be predicted, but a little nibble here and there will gradually lower the cost of conversion.

In the early years of the program, the work of the Office was relatively inexpensive, as it centered principally on literature searches and laboratory experiments. Now, as new processes are moving from the glassware of the laboratory to the hardware of the pilot and demonstration plants, the cost of our operations is increasing sharply. At the

present time we are operating seven pilot plants. We will soon need twice that number to continue the orderly development of new processes. These pilot plants should be pushed forward because we believe they will help find the answer to some of the yet unsolved problems that must be hammered out if we are to produce fresh water from the sea at a lower price than at the present time.

Because of this situation, with Secretary Seaton's full approval, we were in the process of preparing legislation for the consideration of the Congress to expand and extend our authorization when S. 3446 and S. 3557 were introduced. We shelved our activity in this direction when we learned that legislation to accomplish this same purpose had been introduced for the consideration of the Congress, and began instead to prepare testimony for this expected hearing.

We are pleased to report to the committee that the Office is moving forward with enthusiasm and with the full support of the Secretary of the Interior in the demonstration plant program authorized by Public Law 85–883. We have received many compliments from industrial and engineering firms for the work we have accomplished in the short span of less than 2 years since Senate Joint Resolution 135, introduced by Senator Anderson was enacted. Time does not permit me to describe in any detail the effort we have made to comply with the letter and the spirit of that law, but I would like to take just a moment to touch on some of the high points of our activity.

We carefully selected a board of outstanding citizens representing science, industry, and Government, to select the five processes for demonstration plant programing. Members of this Board are: Dr. Ralph A. Morgen, president, Rose Polytechnic Institute, Terre Haute, Ind., Chairman; Dudley F. Phelps, president, the J. G. White Engineering Corp., New York, N.Y.; and Capt. Ivan Monk, U.S. Navy. This Board diligently studied volumes of information prepared by my technical staff as well as information on various processes obtained from many other sources before submitting their recommendations to Secretary Seaton. Their untiring efforts made possible the selection of process that best meet the criteria of the authorizing legislation.

The Site Selection Board of highly qualified engineers with long experience in problems of water supply was appointed to evaluate site applications which were received from every State on our coastal perimeter, from 12 inland States, and from Alaska and Hawaii. Members of this Board are Sheppard T. Powell, Baltimore, Md., Chairman, a mechanical and chemical engineer with over 35 years of experience as a consultant on water problems; Lewis S. Finch, Indianapolis, Ind., vice president and chief engineer, Indianapolis Water Co.; and Dr. Wilburn C. Schroeder, University of Maryland, a professor of chemical engineering and a consultant on engineering and water problems.

Five processes were selected ahead of a rather severe schedule set forth in the authorizing legislation. They are, long-tube vertical multiple-effect distillation, multistage-flash distillation, electrodialysis, forced-circulation, vapor-compression distillation, and freezing. Four sites have been selected: Freeport, Tex.; San Diego, Calif.; Webster, S.D.; and Roswell, N. Mex. The selection of a site for the east coast demonstration plant is presently underway.

In testimony to the through and unbiased work of the Site Selection Board, I would like to report to the committee that in the course of their work they have been forced to face the unhappy task of eliminating over 180 cities from contention as a site for one of these plants, yet our Office has only received two letters of complaint, and these were not from duly constituted officials of any of the eliminated cities, but rather from individual citizens who evidently did not understand some of the requirements of the law.

In addition to the contracts for design and specifications and the construction of the demonstration plant at Freeport, we have also awarded architect and engineering contracts for the second and third plants. Construction funds for the second and third plants will become available July 1 as well as funds for the design and specifications of plants 4 and 5.

The Department of the Interior is pleased with the general purpose of S. 2816, S. 3446, and S. 3557, which provide for an accelerated research, development, demonstration, and practical application of methods for the economical production from the sea or other saline waters of water suitable for agricultural, industrial, municipal and other beneficial consumptive uses.

In his report to the President and the Congress of the operations of the Office of Saline Water, dated February 19, 1960, and which appears in the "Saline Water Conversion Report for 1959," Secretary Seaton included the recommendations submitted by the Saline Water Conversion Advisory Committee following their meeting of December 4, 1959.

The Advisory Committee recommended that the present program should be extended beyond its existing authorization. It further recommended that appropriations within existing authorizations be made for additional demonstration plants designed to demonstrate new processes, or modifications of combinations of existing processes having economic potential and technical feasibility.

This is a very important recommendation. Our estimates indicate that the first five demonstration plants will only require about $8 million of the $10 million authorized by Public Law 85–883.

The Committee recommended that basic and experimental research should be substantially expanded. To expedite this recommendation, on June 13 a newly appointed scientific Board consisting of Mr. Paul L. Davis, chairman, Food Machinery & Chemical Corp.; Dr. R. G. Folsom, president, Rensselaer Polytechnic Institute; Dr. I. Melville Stein, president, Leeds & Northrup Co.; and Dr. Clyde Williams, president, Clyde Williams & Co., will meet to discuss ways and means of improving the quality of the fundamental research emphasis and suggest competent scientists and organizations from whom research proposals should be encouraged.

The Advisory Committee also recommended that the Office of Saline Water be authorized to participate in cooperative research projects in other countries, and should be authorized by visits of staff and consultants to inspect research projects and demonstration plants in other countries and to render reports thereon to the Office of Saline Water and the Congress.

They recommended that the Office should expand its economic studies of water production from saline-water sources, and compara-

tive cost estimates of saline-water conversion should be carefully related to the cost estimates of other sources of water in specific areas.

It was based upon these recommendations that we were preparing the legislation I mentioned earlier. These recommendations are also generally incorporated in the legislation contained in S. 3446 and S. 3557, and with these general provisions we are in wholehearted agreement.

Both title I of S. 3557 and S. 3446 would authorize an urgently needed continuing, accelerated, and expanded saline-water conversion research and development program which we earnestly endorse and support.

Section 103 of S. 3557 and S. 3446 have the purpose of greatly increasing the studies and research of all phases of the program. They would permit a needed expansion of many of the activities that we are doing now. We have contracts for the study of the extraction of byproducts, but much still remains to be done. Many industries are now profitably extracting valuable elements from single strength sea water. Brine effluent from saline-water conversion plants may be concentrated up to four or five times the strength of raw sea water and we expect it to have an industrial value which may offset a part of the cost of producing fresh water from the sea. Many people look to the oceans as a vast untapped source of supply for many rare elements, and rightly so, but I would like to remind the committee that 96½ percent of the oceans are fresh water which is our primary area of interest.

We have awarded contracts to research and industrial organizations, and have a cooperative agreement with the Bureau of Mines for studies and experiments covering two of the toughest problems that still must be solved; namely corrosion and scale. When sea water is heated above 160° F., the dissolved salt precipitates out of solution and forms a scale that fouls heat-transfer surfaces and which can actually build up until it impedes fluid circulation. Sea water, particularly hot sea water, is very corrosive, and the development of low-cost corrosion resistant materials of construction is necessary to cut capital investment and maintenance costs.

The Office has worked cooperatively with the Corps of Engineers, the Office of Civil and Defense Mobilization, the National Science Foundation, the National Bureau of Standards, the International Cooperation Administration, and the Department of State.

In meetings with representatives of OCDM we have explained a secondary use of conversion equipment that may be of tremendous potential value. With only minor adaptations, sea water conversion distillation processes can be utilized to remove radioactive atomic contamination from water. We have also suggested to OCDM the possibility of developing mobile conversion units for use in disaster areas to provide always badly needed fresh water. These units could be especially useful in flood areas where high water has rendered existing treatment facilities inoperable.

We have informed ICA and the Department of State that the low-cost conversion processes that are under development may be an attractive lure to induce underdeveloped water-short countries to look to the West for invaluable technological assistance. The Office of Saline Water feels that the nation that finds a cheap way of producing

potable water from sea or brackish water for the arid areas of the world will do much to enhance that country's prestige in the family of nations.

We have carried on an exchange of information with several foreign countries. We have held meetings with the Director of the United Nations Special Fund on International Problems. We have cooperative agreements with a number of States and with the Bureau of Reclamation, the Bureau of Mines, the Geological Survey, the Atomic Energy Commission, and the Navy's Bureau of Yards and Docks. We have advised the AEC that conversion units could be adapted to concentrate atomic wastes and thereby reduce considerably the problem of atomic waste disposal by reducing the volume of waste to be disposed. We are also working to utilize radioactive isotopes as a source of heat for conversion plants.

There is a real need to develop inexpensive small home units capable of producing 500 to 1,500 gallons of fresh water a day. Several small units will soon be ready for the market, but they will be rather costly. Research may make it possible to develop a conversion unit no larger than an automatic washing machine to sell for less than $500. The Office feels that it should support research for the development of such units as well as plants designed to convert 50 to 100 million gallons per day, but as soon as industry is able and willing to take over the development of a process for commercial production, the Government should step out of any competition with private industry.

Our processes development program, which requires laboratory research and pilot plants, is moving forward rapidly. At present we are working with the Bureau of Reclamation Laboratories in Denver on electrodialysis units. In a short time we will be testing four units employing different membranes and different flow patterns. Two of these units are of American design, one developed by the Netherlands TNO, and one a Japanese unit.

Industry has been developing better membranes for the electrodialysis processes. The new membranes are as much as 30 percent more efficient than they were just 1 year ago. Continued studies lead the Department to feel that membranes can be produced at one-fifth the present cost and with 25 to 50 percent more efficiency. Utilizing an electrodialysis process for the demonstration plant at Webster, S. Dak., we expect to produce 250,000 gallons of fresh water per day at a cost of somewhat less than 75 cents per thousand gallons.

The Carrier Corp. of Syracuse, N.Y., has been operating since last October, the world's first pilot plant designed to produce fresh water from the sea by freezing. This experimental facility is designed to produce fresh water at the rate of 15,000 gallons per day. We have awarded a contract to the Blaw-Knox Co. of Pittsburgh, to erect and operate at St. Petersburg, Fla., a second freezing process pilot plant to test a process developed under OSW contract for Cornell University. Laboratory work under contract with Struthers Wells and Scientific Design for producing larger ice crystals will soon be ready for pilot plant programing. We just recently signed an important contract with the Koppers Co. of Pittsburgh, for an entirely new gas hydrate process that offers much promise.

The Food Machinery & Chemical Co. of San Jose, Calif., is working under a small contract on a revolutionary new liquid technique of

heat transfer. Work on scale control is continuing at Wrightsville Beach, N.C., and three solar distillation pilot plants are under test at Daytona Beach, Fla.

I have just touched briefly on some of the activities we are carrying forward. In all, the office is carrying on over 40 research and development contracts of which 12 are with universities, 11 with research organizations, and 17 with private industry. All of these contracts have been approved because they offer promise of developing shortcuts to more efficient methods of producing potable water. I think you will agree that we are attacking the problem we face on a broad front, but much remains to be done.

We would like to suggest that section 103(a) of S. 3557, if enacted, be amended by adding: "(9) basic research on the physical chemistry of water."

With the lone exception of paragraph 5 of section 104 of S. 3557, which authorizes the establishment of a central laboratory and test site, the Office of Saline Water is now carrying out on a limited scale the provisions of that section and of sections 105, 106, and 107.

The Secretary's Saline Water Advisory Committee recommended that the Office of Saline Water should utilize testing sites and facilities, when such are required, which may be available from other organizations including those of educational institutions, industry, and other Government agencies.

Our present method of carrying on research through contract with universities, private research, and industrial firms has enabled us to engage some of the best minds in the world to work on specific projects. It would be impossible to assemble the high quality of men now engaged by industry into a Federal laboratory. The information we have gained from these highly qualified men with many different points of view is most valuable and has proved to be a successful procedure.

However, our program is rapidly changing and the Office is pleased that this legislation authorizes the establishment of a central laboratory and test site. It might not be wise to proceed immediately with this project, for it would require a substantial expenditure of money for facilities and equipment and perhaps as many as 75 scientists and technicians to run such a laboratory. If this authorization is approved it would enable us to request the necessary funds to establish such a facility as soon as it could be clearly justified. We may soon find it necessary to obtain a test site for future pilot plant operations.

We are presently authorized to support research in foreign countries, but funds available to us have been allocated to higher priority work in this country. Consequently we have passed up several attractive research proposals from other nations.

The Office fully agrees with the purpose of the provision of S. 3557 to assemble current literature, both foreign and domestic, on all phases of the saline water program. This is a much-needed project. We have had translated several Russian papers dealing with the subject. We cosponsored a symposium in 1957, at which time a large number of individuals from foreign countries gave papers in a rewarding exchange of information. The Office staff has been encouraged to join scientific organizations and to actively participate in regional and national meetings. We have received a number of invitations to

international conferences on saline water conversion and we hope we will be able to participate in some of them when circumstances permit. We realize that the United States does not have a corner on the brains of the world, and the exchange of information at such conferences might prove very beneficial.

The Office of Saline Water has published 36 technical reports covering various research activities. To save money, these reports are now published and sold by the Office of Technical Services of the Department of Commerce. Under this arrangement we are able to obtain wider dissemination of the information we have developed from our research contracts, and, at the same time, we do not have to absorb the cost of printing or distribution.

We call the committee's attention to the fact that section 2 of the Case bill (S. 3446) specifically authorizes additional appropriations to finance the research and scientific development program. S. 3557 does not contain a similar section. Such a section, in our opinion, is essential to the continued operation of this program.

Title II of S. 3557 is essentially the same as S. 2816 introduced by Senator Allott. While we are in general agreement that a loan program to provide financial assistance to municipalities in order to provide for the practical application of processes being developed should be carried on, the program seems more properly to be within the responsibility of the Housing and Home Finance Agency. However, if the Congress sees fit to assign this new responsibility to the Department of the Interior, there is no question that Secretary Seaton would see that it was carried out to the very best of his ability.

In conclusion, I would like to again express my appreciation to the members of the committee for the opportunity to testify here today. I want to reassert the Department's strong support of legislation to expand and extend the saline water conversion program.

I want to express my thanks to you, Senator Anderson, for your part in introducing this legislation, and to Senator Johnson and the others who cosponsored the bill, and to the witnesses who appeared today in behalf of this legislation.

I think we are gathered here this morning for the purpose of working out legislation that will permit this country to move forward in an expeditious manner with a progressive and productive program of research, development, and demonstration designed to provide this Nation and the world with economical, reliable, and inexhaustible supplies of fresh water.

We are in general agreement, I am sure, that this should and must be done. It is my sincere hope that we can make a united, bipartisan effort to see to it that the best possible legislation is enacted to provide for the development of low-cost conversion processes that will permit the utilization for the benefit of mankind everywhere, the presently unusable oceans and the vital reserves of brackish inland waters.

This is not a program of Democrats or Republicans any more than it is a program of Christians, Jews, or Mohammedans. For the coming years, its benefits will reach around the globe, bringing blessings that stagger the imagination to forecast.

One of the most serious political and social problems of universal concern is water. In this country, too often we have assumed that two things remain free for all of us, air and water. This is not true

of water, particularly when people are taxed for the water. In many States they are making treaties concerning water to divide it on an equitable basis, if that is possible.

History often repeats itself. I was reading recently that Marco Polo wrote a number of articles about his travels from Italy to Peking, and back. At that time he wrote of many rich areas with gardens and farmlands along his route. Some of the areas are now deserts and they are deserts because the water upon which their richness depended has disappeared.

That can happen to any community that lacks water. It is estimated that the average fresh supply of water in the United States amounts to about 515 billion gallons per day. We are now using around 312 billion gallons per day.

In 1980 the demand for water may be between 585 to 600 billion gallons per day. If this proves to be true we will be short 75 or 85 billion gallons of water each day.

The time to consider doing something about water shortages is now. In many areas, we now must reuse water, and that means the use of treated sewer water for industrial purposes. It will be big business. We must learn how to conserve water. We must learn to hold back and utilize more of the water that falls on the earth.

Sewage effluents are already being used, I am told, in some 200 towns in Texas for agricultural purposes. The effluents are treated. No raw sewage is used in the United States to grow crops. The oceans have an inexhaustible supply of water that can be made usable for industrial or individual uses.

The Office of Saline Water has sensed a crisis. We want to meet it carefully through research and experimentation, and be ready to avert any calamity. In our trips around the world, I think you and I have often seen people living in misery where there was an inadequate supply of water.

In western Nebraska I have seen soil blown away because of the arid climate. I have seen women in many parts of the world carrying water on their shoulders because this most precious ingredient of life is so scarce. We need not ever face such a condition if we devote ourselves to converting the apparently unlimited supply of salt water from the oceans to sweet water for usable purposes.

It can be done.

The experiences and the experiments conducted by our office proves that we are bringing the costs down. It takes a great deal of research. We are making progress.

Great as the potentialities may be, I am confident that the objectives of the low-cost converted water can be obtained with a relatively modest program. I would like to call the committee's attention to the fact that the research and development program of the Office of Saline Water has operated for 8 years with a total appropriation of $5,775,000.

Using these funds cooperatively with industry, the Office of Saline Water has provided the Nation with a good program. The Federal investment in research and development has brought the cost of conversion down farther and faster than in all previous human history. It has captured the interest and attention of many of the arid nations of the world who now look to the potentials of converted sea water as a

reliable source of fresh water supplies, the lack of which is the principal reason for their nations remaining undeveloped.

While we have made substantial and encouraging progress in the first 8 years of the program's existence, it daily becomes increasingly clear that the pace of development must be quickened. The need of additional supplies of fresh water is increasing at an unprecedented pace, and at the same time, we have reached the inescapable conclusion that our demand for fresh water will one day outstrip the natural source of supply.

It is imperative, therefore, that we address ourselves to the business at hand in a cooperative and a dedicated manner to approve authorizing legislation that is the best our minds can devise. From the Department's report on S. 2816, S. 3446, and S. 3557, and from the remarks that I have submitted for the record, I think you will find it is unmistakably clear that we fully support legislation designed to expand and extend the saline water conversion program.

There may be small differences of opinion as to how this can best be accomplished, but I think these differences, if they exist, can easily be worked out. Since S. 2816, introduced by Senator Allott, and title 2 of the bill introduced by Senators Johnson and Anderson, are identical, the Bureau of the Budget has reported that the Housing and Home Finance Agency presently has the authority to make loans to cities and municipalities for the purchase of saline conversion equipment.

However, the Department does not have the authority to contract for the use of such facilities and promote the development and demonstration of such processes. S. 3446, introduced by Senator Case of South Dakota, carries such authorization without providing for a loan program.

If the Congress sees fit to assign the Department of the Interior the authority to make such loans, there is no question but that Secretary Seaton would see that it is carried out to the very best of his ability, but we feel that the loan provision falls more properly within the responsibility of the Housing and Home Finance Agency.

We warmly endorse the provisions of Senate bills 2816, 3557, and 3446, which authorize the Department to conduct research on such plants, and the Bureau of the Budget has offered no objections to the three reports filed by the Department.

We call the committee's attention to section 2 of the Case bill, S. 3446, which specifically authorizes additional appropriations to finance the research and scientific development program. The Johnson-Anderson bill, S. 3557, section 101, page 9, lines 11 and 13, does not contain a similar section.

Such a section in our opinion is essential to continue the operation of the program. At the present time, the Office of Saline Water is carrying on research through contracts with universities, private research, and industrial firms. This has enabled us to engage some of the best minds available to work on specific projects.

It would be impossible to assemble the high quality of men now engaged by industry into a Federal laboratory. This has proved to be a successful procedure. Our program is rapidly changing, how-

ever, and the office is pleased at S. 3557 authorizing the establishment of a central laboratory.

While it may not be wise to proceed immediately with the project, if this authorization is approved it would enable us to request the necessary funds to establish such a facility as soon as it could be clearly justified.

We are in the process of working out an agreement with the State of North Carolina for a 25-acre seashore test site for future pilot plant operations. This area would readily accommodate any future laboratory.

In conclusion, I want to reassert the Department's strong support of the legislation to expand and extend the saline water conversion program. It is our earnest hope that you will act favorably on the legislation now being considered. We firmly believe such action is vital, necessary, and fully justified.

Senator ANDERSON. Thank you, Dr. Miller.

Doctor, I recognize that a representative of the Department testifying before a committee has to be, to some degree, circumscribed by the permission of the Bureau of the Budget and so forth, but I also recognize that if I ask you a direct question you have a right to answer it.

Therefore, I want to ask you this question: If S. 3557 as it might be revised by the committee should be enacted into law, have you any idea of how much money the Office of Saline Water could properly, efficiently utilize during the fiscal year 1961?

Dr. MILLER. There are two guideposts, Senator. Senator Johnson made a speech on the floor of the Senate that I think is reasonable. He suggested $17½ million, which included some $8 million for the construction program.

Senator Case's bill provided $20 million for 5 years beginning in fiscal 1962. It did not go to 1961. I think anything that is provided ought to start now, so that we could get started with vital work.

I might say that we have no money for construction of the Roswell plant or the east coast plant. We have some money for designs and specifications. The funds Senator Johnson suggested in his version and explanation of the bill seems reasonable, there is good working ground between what he and Senator Case have suggested.

Senator ANDERSON. Thank you very much.

I noticed you didn't have money for construction at Roswell. You may remember that I tried to put into the bill $400,000 so that you could start this fiscal year. I believe the conferees between the Senate and the House took it out. But I do want to commend you for your support of the idea of getting underway with construction.

I think what was said this morning by the various witnesses from New Jersey, from California, to take two extreme ends of the land, indicates that they would like to see you get underway with this construction program as you now have it planned.

I hope the committee will bear in mind the language in the Case bill setting out $20 million, the language in Senator Johnson's bill seting up some $17.5 million, in order that some reasonable goal may be established if the bill is to pass.

I was interested in the report on S. 3557, from the Secretary of the Interior, which says:

As we pointed out in that report—

meaning the report on S. 2816—

the Housing and Home Finance Agency already has authority to make loans for community facilities which we are informed includes authority to make loans for saline water plants for community purposes.

I just wonder if anybody from Housing and Home Finance has pointed out to you what might be wrong in the language that is in the bill.

Is there anybody here from the Housing and Home Finance Agency, incidentally, who might testify on this?

Apparently not.

The language is:

We recommend, therefore, that your committee secure the advice of the Housing and Home Finance Agency as to the extent to which the provisions of S. 2816 and title 2 of S. 3557 are unnecessary because of the authority already conferred upon that Agency by existing law.

I commend that statement by the Secretary of the Interior very highly. I intend to ask the staff to communicate with the Housing and Home Finance Agency and have them tell us to what extent they feel these provisions are unnecessary. It would seem to me that if you were making loans of a certain character, the people who know the program can best do it.

I know in the Department of Agriculture, the Department has quite a bit to say about REA loans, because they know something about the farming conditions in the area to be served by the REA loans. I would think that the Housing and Home Finance Agency would have difficulty knowing exactly what the possibilities of success were for a certain program, which your office, Doctor, has probably many times examined critically and on which it has asked the advice of experts.

Dr. MILLER. That is right.

Senator ANDERSON. Senator Allott?

Senator ALLOTT. I would like to follow up the chairman's thoughts there. This is a question that many are going to have to face—that is, that you have here two features.

There is no question but what your agency would be the one that would have the technical information and perhaps be in the best position to judge as to whether or not a loan should be made. On the other hand, if you do the entire thing there, it involves setting up in Interior an extraneous new department for the extent of financing, and with all of the questions that come with financing, the issuance of bonds, the repayments and so forth within the Department of the Interior.

One of the things we might explore is the question of perhaps having the Housing and Home Finance Agency carry on the technical part of the loan alone—that is, the financial part of the loan, the administration of the loan—and perhaps we could tie this in to the survey and feasibility by the Department of the Interior, or something like that.

This is something I think we are going to have to give some thought to.

Senator ANDERSON. I would agree with you, Senator Allott. I only say that this is not unheard of, that one department asks another who has special information on a program. I know when I was in the Department of Agriculture, the question came up of leasing certain lands owned by the Department for oil and gas. I signed the letter to the Department of the Interior asking the Secretary of Interior to take full responsibility for the preparation of the leases and the handling of the leasing conduct, because that was a function normally handled by the Department of the Interior—and I thought very well handled. Therefore, I merely assigned to the Department of the Interior the entire function of handling any leases on agricultural lands.

We might do the same thing here. We might wait until the Office of Saline Water had decided that a $50 million loan for Camden, N.J., was required, and allow the Housing and Home Finance Agency to then take it and handle the necessary papers or preliminary work that might be needed for it. But I think the Office of Saline Water is the only one qualified to decide whether a certain plant seems to be sensible, reasonable, and feasible to be constructed in that location.

Senator ALLOTT. I agree with that. I don't think there is any question. It is not dissimilar to certifying the feasibility of a reclamation project. There is no question in my mind that this particular department is the one that should make these recommendations and be in the position of making the primary and final surveys and decisions perhaps. The question is who handles the mechanics of the financing and how is it done? Perhaps we can work that out.

Mr. Chairman, I have one other thing, if you will bear with me.

I have read or scanned over the report of the Department of the Interior, and Mr. Miller, which was dated January 1960. I also scanned a report which was made by the committee—the Research and Education Committee for a Free World—which I think to some great extent seems to be based upon the factual information of Mr. Miller's report.

I wonder, while we have these technical people here, if we could devote just a few minutes by some of their technical members to the explanation—particularly in view of their having this model—of the three or four chief processes and make them a part of this hearing.

Dr. MILLER. I would like to do that, Senator. First, I might say that we today notified the successful bidder on the long-tube vertical plant in Chicago. Bridge & Iron have received the contract and they are ready to break ground very shortly on the plant at Freeport.

Senator ANDERSON. I am afraid I will have to leave at this point. I would like to express my thanks to you, Dr. Miller, and the members of your staff, for coming.

Senator Allott, would you go ahead with the witnesses? I think this will be very important for our hearings. When you have completed, give the opportunity to anybody else who is present to present a statement.

Senator ALLOTT. Very well, Mr. Chairman.

Senator ANDERSON. Thank you.

Seantor ALLOTT (presiding). I wonder if we could cover these five processes briefly so that we have in this record here a short and concise explanation in layman's language of these processes and the present point of progress.

Dr. MILLER. There are more than five processes that we are working on. I think there are about 40 in the laboratory, or other stages of development, that might show some promise. But there are actually five in the demonstration stage. I will ask Mr. Strobel, Chief of our Processes Development Division to give you the details on that phase of the program.

Mr. STROBEL. There are five processes which have been selected for demonstration. There are a number of others in the laboratory and in stages of pilot plant development. But I will discuss those first five that have been chosen, which were the ones that were the furthest advanced. Briefly these are: First, what we call a distillation process and which we have further designated as long-tube vertical, which is a convenient way of referring to the major part of the equipment which goes into that plant. It is based on the use of heat to produce vapor from salt water and does it in a way that reuses the heat that you put in many times so that it is very efficient. It makes use of a particular evaporator which has long vertical tubes, which is where the name comes from. This is a system in which the scale or deposits you get from sea water as you heat it can be controlled. This process is based on the experimental work which was carried out in smaller equipment at Harbor Island, N.C. The model is the way the plant should look on the million-gallon-per-day size to be built at Freeport, Tex.

Senator ALLOTT. The chief virtue of this process, then, is the utilization of heat and handling it to prevent scale?

Mr. STROBEL. Right.

A brackish water plant is going in at Webster, S. Dak., which will use an electrodialysis process.

Senator ALLOTT. This is just where I became lost in reading my reports. What is that?

Mr. STROBEL. This is one that makes use of special membranes or sheets of material which have certain properties that when you put them into salt water, a stack of them, as a sandwich, and put an electrode or electricity at each end of this stack, the electricity acts on the salt in the water to remove it. The salt is dissolved in the water, and it has certain properties which react to electricity. The salt, when it is in solution, dissolves and breaks down into what we call ions. Some of these have a plus charge and some are negative. We have two kinds of electrodes, positive and negative. When you apply current across the ends, the positive particles in the salt water try to get to one end and the negatives to the other. These membranes have special properties in that they only let these salt particles or ions go to certain places in the stack. These membranes are made up of what we call ion exchange material, which have the property of making the ions go where you want them to. So the net result is that when you put many hundreds of these membranes in a stack, in between the membranes you have channels or compartments of saline water; the water flows parallel to the membranes, and when you have the current on, the

water flowing through the membranes is divided into two streams: One has most of the salt in it and one has a lot of the salt removed. As a result you have a stream of brackish water coming into one side of your stack, and at the other you have two streams coming out, one carrying most of the salt and one having much less salt which is your potable water product.

Senator ALLOTT. The membrane method does not filter water in any sense, but, rather, it creates this ionization condition whereby you separate your water as you have described it here.

Mr. STROBEL. That is correct. The electrodialysis has the ability to remove the salt out part of the water by keeping on placing it in certain membrane compartments.

The electrodialysis plant at Webster will be designed for about 250,000 gallons per day and will operate on brackish water.

The third process is called multistage flash distillation. This one also uses heat, but it is different in that in this case the salt water is heated up to a certain temperature and then it is pumped into a large chamber where the pressure is a little less and, therefore, part of the water evaporates off of the main body of salt water and forms distilled water. Then this same hot salt water, which is now at a little lower temperature, goes to another chamber, which is a little lower in temperature, so that more vapor comes off and forms into distilled water. This is repeated many times, the same stream of hot sea water being flashed many times.

When this vapor that comes off the sea water condenses or goes back to a liquid, it gives up its heat to some more sea water coming back through the chambers, so that most of your heat which is in the sea water to start with, is used to heat new sea water. So really all you supply is the additional heat necessary to bring it up to the initial operating temperature, which might be 200 or so degrees Fahrenheit.

Senator ALLOTT. This is the method in California?

Mr. STROBEL. Yes, sir. That plant will be designed for about 1 million gallons per day also. It is the one that would be at point Loma.

The fourth one that has been selected is also in the general category of a distillation system, but it is quite different in the way it operates. It is a vapor compression system. In this type of system, instead of making re-use of the heat as you did in the LTV where the heat of condensation is used to evaporate water in the next effect, you use vapor compression in one system. The boiling salt water gives off vapor and it goes into a compressor, thus the name, vapor compression. The compressor raises the temperature and pressure of the vapor and feeds it back to the evaporator or boiler where more sea water or brackish water would be evaporated.

In this way, you re-use the same heat of evaporation many times. You get the same effect as you get on the type of plant where you have multiple effects, but on this type you do it in one chamber because you do it by raising the temperature of the vapor so the heat can be reused. A certain amount of steam is condensed and bled off as product water as the process goes on. So you get the advantages of the multiple effect system, but you do it in a different way.

The last process which has been selected has been designated generally as a freezing process. There are several types of these which

are candidates for this fifth process selection. But generally it is very different than any of the other four which have been chosen because, as the name suggests, we are using cooling or a cold temperature to get fresh water from salt water. It is a physical fact that if you take a solution of salt water and lower its temperature enough so that you start getting freezing, the ice crystals which will come out of the salt water are pure water. So these freezing processes are based upon cooling down the water, making ice crystals, separating these from the remaining brine, and then remelting your ice, using the ice to condense water or refrigerant vapors which are formed in the process also.

In summary the process is the freezing of salt water to get ice, getting the brine washed away from that ice, and melting the ice to make fresh water——

Senator ALLOTT. Have you proceeded far enough to give any idea of which of these, of the salt water plants, would tend to give the best results? Or is that pending actual operation?

Mr. STROBEL. One objective of building and operating these plants is to be able to compare and evaluate the different processes. Of course, the law specifies that each plant be a different process. But in addition to that, there are certain processes which are more favorable for one kind of water or one kind of location than another. So you can't take these five, two on brackish and three on sea water, and say which is the best overall process. You will always have one process which would fit better on brackish water than it would say, on the seacoast, or if you are using sea water, you might have an area of very low-cost fuel where something like the multiple effect system would be better; if you had an area where there was high-cost fuel, perhaps the vapor compression system might be better because it would use less fuel per thousand gallons of water. So there are advantages and disadvantages to each process, depending upon its location and the particular conditions.

Then, too, there are unknowns in these processes, which the operation of these plants will show. Then there are other systems coming along in the research laboratory, in small laboratory equipment and in pilot plants, which may prove out to be much better than any of those we have selected and which are now most fully developed.

One further thing I would like to state is that the building and operation of these plants will also point the way to improvements in these particular processes. In other words, we don't know as yet how to make them as good as they can be made. So I don't believe at this time we can say which might be the best, but say we believe these will be in the same general area, costwise and operationwise.

Senator ALLOTT. Thank you very much, sir.

Doctor, do you have anything to add?

Dr. MILLER. No; I think Mr. Strobel has covered it very well.

Senator ALLOTT. Thank you very much, then, Doctor, and Mr. Strobel.

Are there any other people who have statements to make this morning?

If not, the meeting will be adjourned. Thank you very much, gentlemen.

(Whereupon, at 11:59 a.m., Wednesday, June 8, 1960, the hearing was concluded.)

(The following telegram and statement were received subsequent to the hearing and ordered inserted in the record:)

LOS ANGELES, CALIF., *June 8, 1960.*

U.S. Congress, Senate Interior Subcommittee on Saline Water, Washington, D.C.:

Unable to attend in person, see tele-letter attached.

Our saline water conversion plant provides fresh water at 3 cents per 10,000 gallons from sea water. Our experience dates back to year 1941 for Navy ships. We use standard equipment in our process design. We could not work with the saline water conversion bureau as they wanted a U.S. patent disclosure of which we will not give only in war. We have worked with our own capital. Senator Engle knows me and my work and nothing in his report is fast or cheap enough to do this work. Our patent law firm has now notified construction companies to stop using our patents and they are looking for a large cut of pie. We want our share of the awards or we will stump speech and Sunday paper our work in California. My sincere regrets.

E. M. MATTHEWS,
Design Engineer for Matthews Engineering Co., Inc.

STATEMENT OF JOHN T. CURRAN, LEGISLATIVE REPRESENTATIVE, AMERICAN FEDERATION OF LABOR AND CONGRESS OF INDUSTRIAL ORGANIZATIONS

Mr. Chairman, my name is John T. Curran. I am legislative representative for the American Federation of Labor and Congress of Industrial Organizations. We appreciate the opportunity to comment on S. 3557 which would expand and extend the Federal saline water conversion programs under the Department of the Interior.

S. 3557 is sponsored by Senator Lyndon B. Johnson and 21 other Senators with strong bipartisan support. This indicates the mounting concern over adequate future supplies of water for the United States made more acute by sharp increases in population, the accompanying urbanization of the Nation and expansion of water uses for municipal, industrial, and irrigation purposes.

The recent lively interest in the saline water program, as an important element of programs to achieve adequate pure water for the needs of the United States, is highlighted by the serious situations faced by many areas over the country. Some are located along our seacoasts and are facing the problem of where to obtain new sources of water beyond the capacity of existing ones being rapidly used up. Others are in farming areas where heavy drains on deep wells for irrigation pumping have depleted underground reservoirs to the point where the water has become brackish and unusable.

Unless drastic measures are taken to plan and provide for needed water supply on a broad front, including such an expanded saline water conversion program as is outlined in the pending legislation, the situation will rapidly deteriorate to the point where it may well become dangerous to the general welfare of millions of people.

In his statement before the Senate Select Committee on Water Resources, May 26, 1960, Andrew J. Biemiller, director, department of legislation, AFL–CIO, outlined a six-point water resources policy for the United States designed as a framework on which to build forward-looking programs to assure future Americans an abundant supply of clean, pure water.

The AFL–CIO statement by Mr. Biemiller said in part: "Expanded research in resources is vitally necessary. Research fathers progress. Proper and intensive use of the fruits of research will advance water technology. We wish to make special mention of the need to expand the Department of Interior's saline water program * * *."

Leroy Burney, the U.S. Surgeon General, recently predicted that U.S. freshwater requirements in 20 years would outstrip its natural supply by 85 billion gallons daily. A. L. Miller, presently Director of the Interior Department's Office of Saline Water, told this committee on June 8 he thought that if there were a recurrence of severe droughts of the magnitude of the early 1930's, 1953, or of 1957, "a real emergency would occur in thousands of communities in the United States."

It is gratifying, therefore, not only to see the interest now displayed in the Congress in this pressing problem, but also to note that the present administration has done two things:

1. Belatedly resumed in 1956 work on a saline water conversion program which had been started as a 10-year program by the previous administration in 1952 and pushed the program at a more rapid rate after the 1958 enactment of Senate Joint Resolution 135, introduced by Senator Clinton P. Anderson.

2. Admitted through numerous speeches and statements by administration spokesmen for Federal agencies dealing with water resources that the problem is one nationwide in scope. It is a refreshing change from the dictum of President Eisenhower's Cabinet Committee on Water Resources in its 1956 report that there was no such thing as a national water problem—only a series of local ones. It is, however, confusing to weigh the new line of the administration with the President's veto of the vitally needed amendments to the Water Pollution Control Act of 1956.

In 1952, at the outset of the saline water conversion program, the cost of processing fresh water out of salt water was $5 per 1,000 gallons. The Freeport, Tex., conversion plant which is just getting under way hopefully will do the conversion job at about $1 per 1,000 gallons of water processed. Hopes have been expressed that this cost in large-scale demonstration plans will be further reduced.

The need for an expanded program, however, is evident from the fact that the 1958 authorization by Congress of a 7-year pilot plant conversion program to build five designs set an authorization ceiling of only $10 million and made no provision for establishment of a central laboratory, test facilities, and expansion of technical staff. All of these are badly needed by the Office of Saline Water if its program is to move research, pilot, and demonstration programs ahead on a scale commensurate with that of the problem.

The AFL–CIO, therefore, endorses in principle the general policy goals of S. 3557 as being badly needed to place the saline water conversion program of the Federal Government into high gear. Further delay will only serve to make the entire venture more and more costly and prevent the existing program from gradually reverting to a standby basis as the modest goals of the 1958 program are met and vitally necessary research is eliminated as staff is shifted over to run the new pilot plants.

Although the AFL–CIO agrees wholeheartedly in principle with the aims of S. 3557 to accelerate the saline water conversion program, we have the following comments on four aspects of the legislation itself.

1. We agree with the testimony of the Department of the Interior calling attention to the need for specific authorization in S. 3557 for additional moneys necessary to finance the scientific research and development program.

2. We also can take no exception to the Department of the Interior's suggestion that an additional item (9) be added to section 103(a) in order to include "basic research on the physical chemistry of water" as among the important elements of the research and development program as provided by this section of the bill.

3. The AFL–CIO urges that there be strong and unmistakable provisions written into section 103(c) of the bill which will prevent monopolization of any devices invented by any private firm or person and which will retain such inventions in the public domain under a system of cross licensing of patents similar to that renewed just last year by amendment of the Atomic Energy Act of 1954.

4. We oppose the unwieldy procedure outlined in section 203 of S. 3557 which would require submission by the Interior Secretary to Congress with findings and recommendations of each and every application for a loan to construct a saline water conversion plant. Such applications would remain in Congress for 60 days, after which the loan could be made unless the Congress disapproves the application by joint resolution.

This sort of procedure needlessly retains in the Congress what should be the responsibility of the executive agency for execution of this act.

It would inhibit the Department of the Interior from conducting an efficient program without adequate reason for so doing. We call attention to the Water Pollution Act of 1956 whereby the Department of Health, Education, and Welfare (through its subsidiary Office of Water Pollution) grants or rejects loan applications by scores of municipalities as a matter of day-to-day policy under standards and regulations adopted under the broad conditions of the act itself. We regard this as a far more desirable procedure than the one outlined in section 203 of this bill.

The AFL–CIO hopes these suggested changes to S. 3557 will be seriously considered by the Senate Interior and Insular Affairs Committee. We strongly believe they are necessary to provide continuity to the program, provide flexibility of administration under broad congressional directive and prevent its benefits from being monopolized by any private interest.

Thank you for the opportunity of presenting the position of labor on this very important piece of legislation.

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